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## *THE PRINCIPLES OF THE THEORY OF MUTATION*[1]

UNITY of internal structure combined with a great diversity of external forms is the great principle of organic differentiation. Lamarck was the first to point this out and to explain it by his theory of common descent. But the science of his time did not afford a sufficient body of facts in proof of his conception, and he failed to convince his contemporaries.[2]

[1] Address delivered at the University of Brussels, January 17, 1914.

[2] "The Mutation Myth" is the title of a recent article in this journal, N. S., Vol. XXXIX., No. 1005, April 3, 1914, p. 488. Its author, Edward C. Jeffrey, starts from the conception that the mutation theory has been derived from my experiments with *Œnothera Lamarckiana* and allied species. This opinion is indeed, even yet, not unfrequently held by those who have not read my books. It is obviously erroneous and therefore may well be called a myth. Logically and historically the desirability of those experiments has been derived from the theory, as will be seen in the text. Jeffrey bases his arguments upon the well-known researches of Geerts concerning the partial sterility of many of the members of the natural family of the *Onagraceæ*. Geerts found that in almost all the genera of this family, including all their species as far as investigated, the ovules are for one half in a rudimentary condition, which excludes the possibility of their being fertilized, whilst about one half of the pollen grains is sterile. This double character has therefore persisted during the pedigree-evolution of almost this whole family. In contradiction with Geerts, Jeffrey considers it to be an indication of a hybrid condition. If this were true, almost the whole natural family of the *Onagraceæ* would have evolved in a hybrid condition and *Œnothera Lamarckiana* would follow the rule. It remains doubtful, however, how this hypothesis could explain the high degree of mutability of *O. Lamarckiana*, since the majority of the supposed hybrid species do not show signs of such a condition.

It has been the work of Darwin to accumulate a large number of facts and arguments, borrowed from the most diverse parts of the physical and biological sciences, and to combine the main results of the study of nature in general in order to find a conclusive proof of the idea of Lamarck. Common descent is now acknowledged as the natural cause of the unity of organization. Successive slow modifications have produced the great diversity of forms and the diverging lines of evolution which have gradually led to the highest degrees of differentiation.

But his broad views and comprehensive considerations did not suffice to afford the desired proof. Comparative anatomy and systematical studies, the knowledge of the laws of the geographical distribution of animals and plants and of their gradual development during the geological epochs, could only outline the broad features of the theory. Evidently its basis must be sought in the study of the process by which one species is produced from another. Which is the nature and which are the causes of this process? Which are the elementary changes which, by numerous repetitions and combinations, have produced the main evolutionary lines of the animal and vegetable kingdom?

In order to answer these questions, Darwin studied the experience of the breeders. The improvement of domestic animals was well known at his time, the cultivated races of flowers and vegetables, of cereals and sugar-beets clearly and widely surpassed the same species in nature.

The method of breeders is based on the principles laid down about the middle of the last century (1840) by P. P. A. Lévêque de Vilmorin, the father of the celebrated founder of the culture of sugar-beets. He had observed the high degree of variability of cultivated plants and discovered that by means of a choice of the best samples and by their isolation highly improved varieties may be produced. His son has applied this principle to the sugar-beets, one of the most variable of all cultivated forms, and succeeded in increasing the amount of sugar from 7 to 14 per cent. This improvement soon became the basis of a large sugar-industry in many countries of Europe. From that time isolation and selection have become the watchwords of a big new industry, which soon produced the most unexpected results in almost all parts of agricultural practise.

Darwin transplanted this principle of practise into pure science. He studied the variability of species in the wild condition and found it as widely spread and as rich in its features as in cultivated forms. He saw that very many species are distributed in nature in such a way as to constitute numbers of isolated colonies, sufficiently distant from one another to exclude the possibility of intercrossing. He discovered the great factor which replaces artificial selection in nature and called it by the name of natural selection. It is the unceasing struggle for existence and the victory of the most endowed individuals. In nature, every plant produces more seeds than can develop into new plants, owing to lack of space. Only those which are most fit for the surrounding conditions will survive, whilst the remainder are condemned to disappear. In this manner the struggle for life leads to a selection, which will be repeated in every generation, and a whole colony may gradually change by this means until at the end the characters are sufficiently different from the original ones to constitute a new variety or even an elementary species.

Natural selection in the struggle for life has now become the main principle of organic evolution. Since species obey in

the wild condition the same laws as under cultivation, the principles of their improvement must be the same everywhere.

Darwin applied this principle to geological evolution also. Lyell had shown that the laws of nature have always been the same from the very beginning. Therefore natural selection must have been active from the first time of the existence of life on earth and have produced the main lines of differentiation as well as the first traces of all those groups, which are now recognized as families and genera. It is my conviction that the success of Darwin in this line of ideas has been as complete as possible. He succeeded in convincing his contemporaries of the essential analogy between artificial and natural selection.

But, on the other hand, it must be conceded that the practise of breeders was not as simple as it seemed to be. No thorough study of the phenomena of variability had been made, and it was simply assumed that the diversity of forms within the cultivated races was due to one cause only. This was indicated by the well-known expression that no two individuals of a race are exactly alike. All specimens differ from one another in their industrial qualities as well as in their botanical characters. These qualities and characters are inheritable and the offspring of a selected individual will vary, according to Vilmorin, around an average lying between the type of the original species and that of the chosen individual. By this means the range of variability will be extended in the desired direction, and this may be repeated during a number of years, until the industrial value of the new race clearly surpasses that of the old one.

Evidently, it was said, natural selection must work in the same way. But the question remains whether this will really lead to new species, or only to local and temporary adaptations.

The answer to this question has been given by the newest discoveries of agricultural practise itself. Hjalmar Nilsson, the director of the celebrated experimental station of Svalöf in Sweden, discovered that variability among cultivated plants is not a single phenomenon, but contains at least two widely contrasted features.

He found that, apart from fluctuating variability, every cultivated species is a mixture of elementary types. A field of a cereal is only apparently uniform, and a closer investigation soon reveals numerous differences in the height of the stems, in the time of flowering, in the size and almost all other qualities of the ears, in resistance to diseases and especially in the industrial value of the grains. Moreover, he found that all these qualities are strictly inheritable. Nilsson took the grains of a single ear and found that all the individuals issuing from them are strictly alike and carefully repeat the characters of their mother. From such a chosen ear one may derive by repeated sowings grain enough to sow a whole field, and this will show an almost complete and very striking uniformity. Therefore our ordinary species and varieties of cultivated plants are in reality mixtures of a smaller or larger number of different races, which grow together, but are, as a matter of fact, independent of one another. These races themselves are almost invariable, but their mixture in the field produces upon us the impression of a great variability.

What is the significance of this discovery for the explanation of artificial selection? Evidently this will tend to isolate the better races of the mixture and to exclude those of average or low value. Two methods may be followed. Either the breeder collects a handful of ears chosen with the utmost care from all parts of his field and secures a lot of grains large

enough to sow a parcel of a moderate extent. Or he limits his choice to one ear only, which will take him one year more to obtain the necessary quantity of grains. The first method is the one which is still commonly followed, the second was introduced some twenty years ago by Nilsson.

The real nature of the first method may be explained by means of the careful studies of Rimpau, who applied it for the improvement of his rye. The group of ears of the first choice will evidently be itself a mixture, although of a lesser number of types. In choosing year after year a handful of the best ears Rimpau must gradually have purified this mixture, until after twenty years he succeeded completely in isolating the very best one of them. From this time his race must have been pure and constant, no further selection being possible. Using the method of Nilsson the same result may be reached by a single choice, and therefore in one year. The new race is produced by a jump and not by the slow and gradual improvement by small and almost invisible steps, which was assumed by Rimpau and Darwin.

From these discoveries the question arises, whether natural selection also proceeds by jumps and leaps, and not, as was commonly assumed, by imperceptible steps. The answer may be deduced from the observations of Jordan and others on the existence of elementary species in nature. Almost every wild species consists of some of them, and in special cases their number increases so as to embrace dozens or even hundreds of sharply distinguished types. Sometimes these are found in widely distant stations; at other times, however, they are growing in mixtures. Natural selection will, of course, under changed conditions, simply multiply one or two of the types to the exclusion of the others. As a whole, the species will make progress in the desired direction, but in reality there will be no change of forms.

From all these and many other considerations it follows that the basis, which the practise of artificial selection seemed to afford to the theory of natural selection, is a fallacious one, and that the idea of evolution by means of slow and almost imperceptible steps must therefore be abandoned. But if this is conceded, how are species really produced in nature?

The theory of mutations answers that species are produced by means of jumps and leaps, exactly in the same way as varieties in horticulture. Varieties are only beginning species, says Darwin, and the same laws must govern the origin of both of them. Now, in horticulture, it is well known that varieties usually arise at once. In a field of a species with blue or red flowers some day an individual with white flowers is seen. Ordinarily it is only one, and it is not surrounded by transitions or by flowers of intermediate colors. Sometimes there may be two or three, but then their flowers are of the same degree of whiteness. One seed of the species has been transformed into a variety, and this is its whole origin. A single season suffices to produce the effect, no slow and gradual improvement being required. Moreover, the seeds of the first individual, if fertilized and saved separately, will reproduce the variety wholly pure. The same rule prevails for large groups of other cases; everywhere varieties arise by jumps, requiring only one year for their arrival.

The same rule also holds good in nature. But in order to show this, direct experiments are required. For this object I have cultivated a large number of wild species in my experiment garden, trying to see them produce varieties and to be enabled thereby to study the laws of this process. Let me adduce two instances, the origin of the

peloriated toadflax and that of the double variety of the corn marigold. These varieties appeared in my cultures all of a sudden, after a number of years, the one in about half a dozen of individuals in successive generations, the other in a single instance. The ordinary toadflax has only one spur on its flowers and remained so in hundreds of individuals until a single specimen bore five spurs on every one of its flowers. The corn marigold had normal flower heads until 1899 when one individual produced some slight signs of duplication. Next year all its descendants bore double flowers and the race showed itself constant from the very beginning.

Thus, the production of varieties by leaps and jumps may be considered as a well-proved fact in horticulture and in a state of nature. It is a firm basis for a new theory, and we have only to transport the principle from the varieties to the origin of elementary species. Recognized for species, the theory will obviously be true for genera and families also, and explain the evolution of all organic beings in all the different lines of the genealogical tree.

The idea of the origin of species by leaps and jumps has the great advantage of answering in an unexpected and decisive way the numerous and in part very grave objections which have been brought forward against the theory of Darwin. To my mind, this is one of the best arguments in its favor. It releases the theory of evolution from the serious difficulties which its adversaries have never ceased to urge against it. Therefore it seems useful to give a brief survey of them now.

The oldest and most serious objection is based on the obvious uselessness of new characters during the first stages of their evolution, if this is supposed to be invisibly slow. Imperceptible odors can not guide insects in their visits to flowers and assure to these a sufficient advantage in the struggle for life. Adaptations for the capturing of insects by plants would be of no value in a primary and imperfect condition and therefore can not be evolved by the action of natural selection. Imperfect instincts would be rather obnoxious, according to Wasmann, and thus would be liable to be destroyed instead of increased by this action. So it is in many other cases. Beginning characters would always be too insignificant to be of any value in the struggle for life. Evidently the principle of leaps and jumps at once relieves us of the necessity of this hypothesis. It does not admit a gradual appearance of characters, but assumes these to appear at once in the full display of their development, and without the aid of natural selection.

The same holds good for useless characters. The theory of Darwin can not explain them. According to him, every quality is developed exactly through its utility, and useless properties should be eliminated from the very beginning by the struggle for life. But it is now generally recognized that many beautiful differentiations are in reality no adaptations at all, and that their usefulness is at least very doubtful. This, for instance, is the case of heterostyly and of the likeness of the flowers of some orchids to insects. The theory of mutations has no difficulty with useless and even with slightly prejudicial characters. Arising by a sudden jump, they may keep their place, provided only that they are not in such a degree hurtful as to prevent a normal development of the individuals.

A third objection has been derived from the studies of the celebrated anthropologist Quetelet, who discovered the general law of fluctuating variability. He introduced the principle of studying every quality for itself and of comparing the different

degrees of its development in a large number of individuals. He found by this means that characters simply follow the laws of probability. They vary around an average condition in two directions, of increase and decrease, but precisely thereby this variability excludes the production of a new character. Darwin tried to derive the one from the other, whilst the theory of mutations recognizes the almost diametrically opposed nature of the two phenomena.

A last objection has been brought forward by the study of the age of the earth. Physicists as well as astronomers have refused to accept the theory of slow evolution as the time required by Darwin in connection with his ideas, seemed by far too long. A man's life would not suffice to see the changes, which, after him, would be necessary to produce a single step in the line of evolution. The differentiation of a flower or of a seed would require millions of years if it went on so slowly, and the development of the whole organism of a plant, and still more so that of the higher animals, would obviously require a vastly larger amount of time. Darwin has calculated the necessary time for the evolution of the whole animal and plant kingdom on the assumption of slow and almost imperceptible changes, and estimated it to be at least equal to some thousands of millions of years.

But our globe can not be as old as that. There is quite a large number of arguments which allow us to estimate the age of the earth with a sufficient degree of accuracy, and they all point, unanimously, to a period of only some twenty or forty millions of years. This number is evidently far too small for the explanation given by Darwin and in consequence thereof it has always been considered as one of the most decisive arguments against the theory of slow and gradual evolution.

In order to estimate the age of the earth different phenomena may be used. First the separation of the moon, secondly the solidification of the earth's crust, then the condensation of the aqueous vapor and the formation of oceans. The quantity of salt dissolved in these oceans and the thickness of the geological layers, especially those of a calcareous nature, afford further arguments.

According to George Darwin the moon was separated from our globe about 56 millions of years ago. The age of the solid crust has been calculated by Lord Kelvin from the increase of the temperature in deep mines. In some regions the temperature is seen to increase about one degree for every fifty meters; in others, however, one degree for a hundred meters. On the average the considerations of Lord Kelvin gave an age of twenty to forty millions of years for the solid crust of the earth.

The quantity of salt obviously increases in the oceans on account of the salt added by the rivers and of the evaporation of the water. The total quantity of this salt has been calculated and the quantities of the yearly supply of water are known for all the larger streams, as well as their percentage of salt. From these data we may calculate the annual increase of salt in the oceans and find how many years would be required for our present rivers to accumulate all the salt now found in the seas. According to Joly, about ninety millions of years would be necessary. But obviously the rivers must exhaust the grounds which they drain, and formerly these must therefore have been much richer in salts. This consideration must lead us to diminish the number of years required in a very sensible manner.

The age of the geological strata has been deduced from their thickness and the velocity of the process of sedimentation.

Sollas estimates the total thickness at about 80 kilometers and the average rate of deposition of the layers at 30 cm. per century. From these numbers we may find an age of 26 millions of years for the collective deposition of all the geological layers. Calcareous rocks have been built by organisms and mainly by corals and molluscs. These have made use of the lime added to the sea by the rivers. Dubois has calculated on the one hand the whole thickness of these rocks and on the other the yearly supply of lime from the rivers. He concludes that 36–45 millions of years would be required to produce the whole of this system.

All these data have been subjected to a criticism by Sollas and compared with one another. Obviously the highest estimates are only limits, and in considering this, Sollas arrives at the general average of about 20–40 millions of years. He points out that the epochs which have served as starting points are not very far distant from one another, considered in a geological way, and that therefore they may be taken together to delineate the duration of organic life on this earth.

As we have seen, this duration is by far too short to allow the slow and gradual development of life supposed by Darwin. It necessitates a very substantial abbreviation of this process and thus affords one of the best supports of the theory of mutations.

Thus we see that this theory is based on almost all the branches of natural science. All of them join in the assertion that the hypothesis of slow and almost invisible changes is too improbable to be accepted and is even in open contradiction to some of the best results of other sciences. The theory of an evolution by leaps and jumps evades all these objections and thereby releases the theory of Darwin from its separate position.

But it is doing more than this. By rejecting the hypothesis of invisible changes it leads us to search for the visible alterations, which it assumes to be the leaps and jumps by which animal and vegetable species are being produced. If the transformation of one species into another is a visible process, it must evidently be sought for and be brought to light in order to study its laws, and to derive from this study an experimental proof for the theory of evolution.

However, it is hardly probable that these jumps are numerous in nature as it now surrounds us. On the contrary, they must rather be rare, since nobody had seen them until now in the field. Therefore I have sought for a plant which would produce more of such mutations than other plants. I have studied over a hundred species, investigating their progeny, and among them one has answered my hopes. This is the evening primrose of Lamarck, which chances to bear the name of the founder of the theory of evolution which it is prepared to support. It is a species which grew wild in the territory of the United States, where it has been collected by the well-known traveler and botanist Michaux, and whence Lamarck derived the authentic specimen for his description. Since that time it has spread in Europe and is now found especially in England, Belgium and Holland in a number of localities, some of which consist of many thousands of individuals. In more than one of these localities it has been observed to produce mutations, especially in a field near Hilversum in Holland, whence I have obtained the individuals and seeds which have served as the starting points of my cultures.

In these cultures the species is seen to be very pure and uniform in the large majority of its offspring, but to produce on an average one or two aberrant forms in every

hundred of its seedlings. The differences are easily seen even in young plants and are mostly large enough to constitute new races. The more common ones of these races are produced repeatedly, from the seed from the wild plants as well as in the pure lines of my cultures. It is obviously a constant and inheritable condition which is the cause of these numerous and repeated jumps.

These jumps at once constitute constant and ordinarily uniform races, which differ from the original type either by regressive characters or in a progressive way. By means of isolation and artificial fecundation these races are easily kept pure during their succeeding generations.

I shall not insist here upon their special characters. The most frequent form is that of the dwarfs, *Œnothera nanella,* and the rarest is the giant, or *O. gigas,* which has a double number of chromosomes in its nuclei (28 instead of 14) and by this mark and its behavior in crossing proves to be a progressive mutation. Other new types which are produced yearly are *O. rubrinervis, O. oblonga* and *O. albida. O. lata* is a female form, producing only sterile pollen in its anthers and *O. scintillans* is in a splitting condition, returning every year in a greater or less number of individuals to the original type from which it started. Besides these there are a large number of mutations of minor importance, many of which have not even been described up to the present time.

Thus we see that the experiments provide us with a direct proof for the theory of evolution. They constitute an essential support of the views of Darwin, and moreover they relieve them of the many objections we have quoted and bring them into harmony with the results of the other natural sciences.

But, besides this, they show us the way into a vast new domain of investigation and afford the material for a study of the internal and external causes which determine the production of new species, at least in those cases in which, as in the primroses, mutations are relatively abundant. From these we may confidently hope to come some day to the study of those rarer mutations on which the differentiation of the main lines of organic evolution seem to have depended.

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## *THE PROBLEM OF LIGHTING IN ITS RELATION TO THE EFFICIENCY OF THE EYE*[1]

Up to the present time the work on the problem of lighting has been confined almost entirely to the source of light. The goal of the lighting engineer has been to get the maximum output of light for a given expenditure of energy. Until recent years little attention has been given to the problem in its relation to the eye. It is the purpose of this paper to outline in a general way some of the more important features of this phase of the subject, and to give some of the results of work that is now being done on the problems that these features present.

Confronting the problem of the effect of lighting systems on the eye, it is obvious that the first step towards systematic work is to obtain some means of making a definite estimate of this effect. The prominent effects of bad lighting systems are loss of efficiency, temporary and progressive, and eye discomfort. Three classes of effect may, however, be investigated: (1) the effect on the general level or scale of efficiency for the fresh eye; (2) loss of efficiency as the result of a period of work; and (3) the tendency to produce discomfort. Of these three classes of effect the last two are obviously the more important, for the best lighting system is not the one that gives us the maximum acuity of vision

[1] This paper, with some changes, was read before the American Philosophical Society of Philadelphia, April 4, 1913.

for the momentary judgment or the highest level of efficiency for the fresh eye. It is rather the one that gives us the least loss of efficiency for a period of work, and the maximum of comfort.

In 1911 the American Medical Association appointed a committee to study the effect of different lighting systems on the eye. The writer was asked to share in the work of this committee. The problem presented to him was to furnish tests that would show the effect of different lighting systems on the eye, and more especially to devise, if possible, a test that would show loss of efficiency as a result of three or four hours of work under an unfavorable lighting system. In his work directed along these lines he has succeeded in getting methods of estimating effect which after eighteen months of trial seem sufficiently sensitive to differentiate between good and bad lighting systems with regard to these points. He has undertaken, therefore, to determine (1) the lighting conditions that give in general the highest level or scale of visual efficiency; (2) the conditions that give the least loss of efficiency for continued work; and (3) the conditions that cause the least discomfort. This plan of work, it is scarcely needful to remark, will involve a wide range of experimentation. The crux of the problem is, however, to secure reliable methods of estimating effect. Having these methods, the factors, whatever they may be, distribution, intensity, quality, position of the light relative to the eye, etc., can be varied one at a time and the effects be determined. From these effects it should not be difficult to ascertain what lighting conditions are best for the eye, and what is the relative importance of the factors that go to make up these conditions. Further, it should be possible on the practical side to test out and perfect a lighting system before it is put on the market; also to determine the best conditions of installation for a given lighting system; to investigate the effect of different kinds of type and paper on the eye; to study the effect of different kinds of desk lighting, etc. In short, it is obvious that the usefulness of such tests is limited along these lines only by their sensitivity.

A detailed description of the tests we are using has already appeared in print.[2] Time can not be given to them here. A brief report only of some of the results of the work in which they have been employed is possible in the time placed at my disposal.

In the study of the problems presented to us in this field it has been thought best to conduct the investigation at first along broad lines in order to determine in a general way the conditions that affect the efficiency and comfort of the eye. Later a more detailed examination will be made of the ways in which these conditions have been worked out in the various types of lighting systems in use at the present time. The following aspects of lighting sustain an important relation to the eye: the evenness of the illumination, the diffuseness of light, the angle at which the light falls on the object viewed, the evenness of surface brightness, intensity and quality. The first four of these aspects are very closely interrelated, and are apt to vary together in a concrete lighting situation, although not in a 1:1 ratio. For the purposes of this paper these aspects will be grouped together and referred to as the distribution of light and surface brightness in the field of vision, or still more generally as distribution. The ideal condition with regard to distribution is to have the field of vision uniformly illuminated with light well diffused and no extremes of surface brightness. When this condition is attained, the illumination of the retina will shade off more or less gradually from center to periphery, which gradation is necessary for accurate and comfortable fixation and accommodation.

The factors we have grouped under the heading distribution can be most conveniently discussed perhaps with reference to four types of lighting systems in common use

[2] "Tests for the Efficiency of the Eye Under Different Systems of Illumination and a Preliminary Study of the Causes of Discomfort," *Transactions of the Illuminating Engineering Society*, 1913, VIII., pp. 40–60.

to-day: illumination by daylight, direct lighting systems, indirect lighting systems and semi-direct systems. In the proper illumination of a room by daylight, we have been able thus far to get the best conditions of distribution. Before it reaches our windows or skylights daylight has been rendered widely diffuse by innumerable reflections; and the windows and skylights themselves, acting as sources, have a broad area and low intrinsic brilliancy, all of which features contribute towards giving the ideal condition of distribution stated above, namely, that the field of vision shall be uniformly illuminated with light well diffused and that there shall be no extremes of surface brightness. Of the systems of artificial lighting the best distribution effects, speaking in general terms, are given by the indirect systems. In this type of system the source is concealed from the eye and the light is thrown against the ceiling or some other diffusely reflecting surface, in such a way that it suffers one or more reflections before it reaches the eye. In some of the respects most important to the eye, this system gives the best approximation of the distribution effects characteristic of daylight of any that has yet been devised. The direct lighting systems are designed to send the light directly to the plane of work. There is in general in the use of these systems a tendency to concentrate the light on the working plane or object viewed rather than to diffuse it, and, therefore, a tendency to emphasize brightness extremes rather than to level them down. Too often, too, the eye is not properly shielded from the light source and frequently no attempt at all is made to do this. The semi-indirect systems are intended to represent a compromise between the direct and indirect systems. A part of the light is transmitted directly to the eye through the translucent reflector placed beneath the source of light, and a part is reflected to the ceiling. Thus, depending upon the density of the reflector, this type of system may vary between the totally direct and the totally indirect as extremes and share in the relative merits and demerits of each in proportion to its place in the scale. By giving better distribution this type of system is supposed also to be a concession to the welfare of the eye, but our tests show that the concession, at least for the type of reflector we have used,[3] is not so great as it is supposed to be. In fact, installed at the intensity of illumination ordinarily used or at an intensity great enough for all kinds of work, little advantage is gained for the eye in this type of lighting with reflectors of low or medium densities; for with these intensities of light and densities of reflector, the brightness of the source has not been sufficiently reduced to give much relief to the suffering eye.[4] Until this is done in home, office and

[3] The reflectors we used were supplied to us by a prominent lighting corporation, interested neither in the manufacture nor the sale of lighting fixtures, in response to a request for a representative semi-indirect lighting system. Obviously, however, final conclusions should be reserved until the tests are extended to other types of reflectors.

[4] The semi-indirect system used by us was but little better for the eye than the direct system. The direct system we employed was the one in general use throughout the building in which our tests were made. It was installed about six years ago and is, therefore, not of the most modern type. It seems to the writer safe to say, however, that it gives effects fully as good as most direct lighting in actual use in the country to-day. Furthermore, it is difficult to believe that any great injustice has been done to direct lighting, so far as this principle of lighting has been commercialized up to this time, by the selection of this system, because of the fact that very little less loss of efficiency was obtained from the semi-indirect lighting system, which on account of its similarity to indirect lighting represents, we have good reason to believe from our results, a greater modification of direct lighting for the welfare of the eye than any that is found within the class of direct systems. However, a final conclusion will be reserved until a more extensive investigation of the direct systems has been made. The writer further does not wish to be understood as contending that direct lighting can not be accomplished in a way that is not excessively damaging to the eye. Doubtless great improvement can be made in this type of lighting if proper attention is given to the fundamental principles governing the effect of light on the eye. It does not seem to the writer, however, that the prin-

public lighting we can not hope to get rid of eye-strain with its complex train of physical and mental disturbances.

It is not our purpose, however, at this time to attempt a final rating of the merits of lighting systems. For that our work is still too young. Moreover, there are relatively good and bad systems of each type, and good and bad installations may be made of any system. What we hope to do is by making an appropriate selection and variation of conditions to find out what the factors are that are of importance to the eye, and from this knowledge as a starting point to work towards reconstruction.

With regard to the effect of the distribution of light and surface lightness on the eye a brief statement will be given here only of its effect on efficiency; and in the consideration of efficiency loss of efficiency will receive the major part of our attention. No attempt will be made, for example, to present the results of the study of the factors producing discomfort. The study of these factors has constituted for us an entirely separate and independent piece of work investigated by separate and independent methods.

Our tests for loss of efficiency[5] show that when the intensity and quality of the light are equalized at the point of work, the eye

ciple of direct lighting offers as great possibilities in this direction as the indirect; still he permits this also to remain an open question in his mind. It is obvious that much can be accomplished for the welfare of the eye in cases both of the direct and semi-indirect systems by using sources of large area and of low intrinsic brilliancy, by removing them as much as possible from the field of vision, by employing better means of diffusing the light, etc.

[5] The tests were made in a room 30.5 feet long, 22.3 feet wide, and 9 feet high. The artificial lighting was accomplished by means of two rows of fixtures of four fixtures each. Each row was 6 feet from the side wall and the fixtures were 6 feet apart. The reflectors were in the different cases 19–26 inches from the ceiling. Clear tungsten lamps were used as source. The voltage was kept constant by means of a voltmeter and a finely graduated wall rheostat placed in series with the lighting circuit. In case of the direct system two bulbs making an angle of 180° were used for each fixture and the distribution was obtained by means of white slightly concaved porcelain reflectors 16 inches in diameter fastened directly above. In case of the indirect system corrugated mirror reflectors, enclosed in brass bowls, were used. For the semi-indirect system the distribution was obtained by means of inverted alba reflectors 11 inches in diameter which threw a part of the light against the ceiling and transmitted the rest directly to the room, minus a rather large absorption quantity. The daylight illumination came from three windows all on one side of the room and situated in a line parallel with the line of sight used when making the tests. These windows were so sheltered that it was never possible for them to receive light directly from the sun or from a brightly illuminated sky. Moreover, the light from one of them, the one nearest the observer, was further diffused by passing through a diffusion sash made of double thick glass ground on one side. The intensity in foot-candles was made equal at the point of work for all the systems employed. In making this equalization the light was photometered in five directions at the point of work: with the receiving surface of the photometer in the horizontal plane, at angles of 45° and 90° pointing towards the observer, and at angles of 45° and 90° pointing in the opposite direction. In installing the lights in the different systems it was impossible to make the intensity equal in all of these directions. Care was taken to make it equal in the plane of the test card, *i. e.*, the vertical plane, and as nearly as possible equal in the other planes. The Sharpe-Millar portable photometer was used to make these measurements, also another method mentioned in a former paper (*op. cit.*, p. 49) which is more sensitive to daylight illumination than is the Sharpe-Millar method. The effect of varying distribution of light was thus tested under conditions in which quality and intensity were reduced as nearly to a constant as was possible with the systems employed. The intensity in the vertical plane was made in each case 1.4 foot-candles or approximately so. Space can not be taken here for an engineering specification of the installations used and the lighting effects produced. A full report of the work including detailed brightness and illumination measurements, photographs showing the illumination effects obtained, descriptions of installations, etc., will be published in the *Transactions* of the Illuminating Engineering Society.

loses practically nothing in efficiency as the result of three to four hours of work under daylight. It loses enormously for the same period of work under the system of direct lighting selected for our work and almost as much under the system of semi-indirect lighting. Under the system of indirect lighting, however, the eye loses but little more than it loses in daylight. The results of these tests show also that acuity of vision as determined by the momentary judgment is higher for the same foot-candles of illumination for the daylight system than for the systems of artificial lighting, and that for the latter systems, it is highest for the indirect system, next highest for the semi-indirect system, and lowest for the direct. It will thus be seen that for all purposes of clear seeing, whether the criterion be maximum acuity or the ability of the eye to hold its efficiency for a period of work, the best results are given in order by the systems that give the best distribution of light and surface brightness. The effect of distribution is not so great, however, on the ability of the fresh eye to see clearly as it is on its power to hold its efficiency.

The loss of efficiency found in the above work seems to be predominantly, if not entirely muscular, for the tests for the sensitivity of the retina show practically no loss of sensitivity as the result of work under any of the lighting systems employed. The following reasons are suggested why the muscles of the eye giving both fixation and accommodation should have been subjected to a greater strain by the systems of direct or semi-direct lighting, than by the system of indirect lighting or daylight. (1) The bright images of the sources falling on the peripheral retina which is in a perpetual state of darkness-adaptation, as compared with the central retina, and is, therefore, extremely sensitive in its reaction to such intensive stimuli, set up a reflex tendency for the eye to fixate them instead of, for example, the letters which the observer is required to read. (2) Likewise, a strong reflex tendency to accommodate for these brilliant sources of light, all at different distances from each other and the lettered page, is set up. (3) These brilliant images falling on a part of the retina that is not adapted to them, causing as they do acute discomfort in a very short period of time, doubtless induce spasmodic contractions of the muscles which both disturb the clearness of vision and greatly accentuate the fatiguing of the muscles. The net result of all these causes is excessive strain, which shows itself in a loss of power to do work. In the illumination of a room by daylight, however, with a proper distribution of windows, the situation is quite different. The field of vision contains no bright sources of light to disturb fixation and accommodation and to cause spasmodic muscular disturbances due to the action of the intensive light sources on the dark-adapted and sensitive peripheral retina. As has already been pointed out, the light waves have suffered innumerable reflections and the light has become diffuse. The field of vision is comparatively speaking uniformly illuminated and there are no extremes of surface brightness. The illumination of the retina, therefore, falls off more or less gradually from center to periphery, as it should to permit of fixation and accommodation for a given object with a minimum amount of strain.

It is not our purpose, however, to contend that distribution is the only factor of importance in the illumination of a room. We have chosen to begin our work with types based on distribution, only because it has seemed to us, both from our own work and from a survey of the work done by others, that this is the most important factor with which we have yet to deal in our search for the conditions that give minimum loss of efficiency and maximum comfort in seeing. The quality of light and its intensity at the source are already pretty well taken care of, apparently better taken care of, at least in general practise relative to their importance to the eye, than is distribution. A systematic study of factors, however, can not stop with an investigation of the effect of distribution alone. The intensity and quality of light must also be taken into account. For example, one of the most persistent questions asked by the illuminating engineer is, "How

much light should be used with a given lighting system to give the best results for seeing?" We have undertaken, therefore, to determine the most favorable range of intensity for the four types of distribution mentioned above. Curves have been obtained showing the effect on the efficiency of the eye of three or four hours of work under different intensities of light, for the direct and semi-indirect systems; and rough comparisons have been made for the indirect system and for daylight. Detailed tests will be made for these latter two systems early next year. Our tests show, in general, the following results. A very wide range of intensity is permissible for daylight and the indirect system. For the semi-indirect system the eye falls off heavily in efficiency for all intensities with the exception of a narrow range on either side of 2.2 foot-candles, measured at the level of the eye at the point of work with the receiving surface of the photometer in the horizontal plane. For the direct system no intensity can be found for which the eye does not lose a very great deal in efficiency as the result of work. Thus it seems that distribution is fundamental. That is, if the light is well distributed and there are no extremes of surface brightness as is the case for daylight and the indirect systems of artificial lighting, the ability of the eye to hold its efficiency is, within limits, independent of intensity. In short, the retina is itself highly accommodative or adaptive to intensity, and if the proper distribution effects are obtained, the conditions are not present which cause strain and consequent loss of efficiency in the adjustment of the eye.

Details of the conditions of installation and of the methods of working can not be given here. It will be sufficient to state that the work was done in the same room, with the same fixtures, and in general with the same conditions of installation and methods of working as were used in the tests for distribution. Nor can a full statement of results be made. Time will be taken, however, for a more detailed examination of the results obtained for the direct and semi-indirect systems. For the semi-indirect systems, our test showed that the intensity most favorable to the eye was secured when the photometric reading with the receiving surface in the horizontal plane showed 2.2 foot-candles of light at the point of work, 1.52 foot-candles in the 45° position, and .58 foot-candle in the vertical position. At this intensity of illumination, the semi-indirect system, so far as its effect on the eye's loss of efficiency is concerned, compares fairly well with the indirect system at such ranges of intensity as we have employed. At intensities appreciably higher than this most favorable value, or lower, the loss of efficiency is very great. At the intensity commonly recommended in lighting practise, the semi-indirect system is almost, if not quite, as damaging to the eye as the direct system. The intensity recommended by the Illuminating Engineering Society, for example, in its primer issued in 1912, ranges from 2–3 to 7–10 foot-candles, depending upon the kind of work. Five foot-candles is taken as a medium value. This medium value, it will be noted, is more than double the amount we have found to give the least loss of efficiency for the type and installation of semi-indirect system we have used. The intensity we have found to give the least loss of efficiency for this type of lighting, does not, however, give a maximum acuity of vision as determined by the momentary judgment. At an intensity that does give maximal acuity for the momentary judgment the eye runs down rapidly in efficiency. That is, in this type of lighting, one or the other of these features must be sacrificed. High acuity and little loss of efficiency can not be had at the same intensity. They could both be had only under the indirect system and daylight. However, the amount of light we find to give the least loss of efficiency seems to be sufficient for much of the work ordinarily done in the home or office. It is not enough, though, for drafting or work requiring great clearness of detail.

In case of the direct system, we were able to improve the conditions, so far as loss of efficiency is concerned, by reducing the inten-

sity; but the system never proved so favorable in this regard as even the semi-indirect system. In the tests made under the direct system care was taken to have the fixtures in the same position in the room in every case as they were for the semi-indirect system. The most favorable intensity is secured by an installation that gave 1.16 foot-candles in the horizontal, .85 in the 45° position and .45 in the vertical. At this intensity, however, the loss in the efficiency of the eye for three hours of work was almost four and one half times as great as for a wide range of intensities for either the indirect system or daylight.

Two facts, then, may be emphasized at this point. (1) Of the lighting factors that influence the welfare of the eye, those we have grouped under the heading distribution apparently are fundamental. They seem to be the most important we have yet to deal with in our search for the conditions that give us the minimum loss of efficiency and the maximum comfort in seeing. If, for example, the light is well distributed in the field of vision and there are no extremes of surface brightness, our tests seem to indicate that the eye, so far as the problem of lighting is concerned, is when the proper distribution is present, intensities high enough to give the maximum discrimination of detail may be employed without causing appreciable damage or discomfort to the eye. (2) For the kind of distribution effects given by the majority of lighting systems in use at the present time, our results show that too much light is being employed for the welfare and comfort of the eye.

The effect of quality of light on the eye has been the subject of much discussion and much misunderstanding. There seems to be a feeling even among lighting engineers and ophthalmologists that colored light gives better results for seeing than white light. Some, for example, hold that the kerosene flame furnishes the ideal source of light and that its virtues are due largely to the yellow quality of the light it gives off. While the writer has not as yet begun a systematic study of the effect of quality of light, and while he is, therefore, not as yet willing to commit himself on this point, he will say that when intensity and distribution are equalized, an installation of clear carbon lamps, which gives a light comparatively rich in yellow and red, causes the eye to fall off more in efficiency as the result of 3–4 hours of work than an installation of clear tungsten lamps, the light from which is more nearly white. In short, the question whether or not white or colored light is better for the eye can not be answered until definite tests are made of this point alone under conditions in which all other factors are rendered constant. The effects of the kerosene flame, for example, as compared with other sources of illumination, must be tested under a system of installation that gives the same intensity at the source, and, as nearly as possible, the same distribution in the field of vision as is given by other illuminants. This has not been done at all. Our judgment of the comparative merits of the color quality of the light given by it have been based on the roughest kinds of impression, obtained under conditions of installation in which there has been no attempt at control of the other factors that influence the effect of light on the eye. The work that has been done up to this time on the relation of quality of light to seeing has been confined to visual acuity as determined by the momentary judgment, and even this work which alone can give no safe grounds at all for drawing general conclusions as to the effect of light on the welfare of the eye, shows, whenever the comparison has been made, that white light gives a greater acuity of seeing than light with a dominant color tone. If, as has been maintained by some on the grounds of their working experience, the kerosene flame is easier on the eye than the more modern sources of illumination, the writer would be inclined, more especially in view of his results on the effect of differences in intensity on the efficiency of the eye, to ascribe the benefit, whatever there may be, to the low intrinsic brilliancy of the kerosene flame. For, as has already been stated, it may be safely said that for the kind of distribution effects we are getting from the large majority of our light-

ing systems, too much light is being used for the welfare and comfort of the eye. Added to this is the effect of the position of the light in the field of vision. The kerosene lamp may be placed at the back or side of the person using it, and, if in the field of vision, it is usually at or near the level of the eye. In the two former cases the effect of concealed lighting is given, and in the latter case the lamp occupies the most favorable position possible for an exposed source. That is, if the source of light is to be in the field of vision at all, it should be as nearly as possible at the level of the eye. This is because of the greater tendency of a light source to produce discomfort and loss of efficiency when its image falls on the upper and lower halves of the retina than when it falls in the horizontal meridian. These facts have been clearly brought out in our work on the effect of position of the light in the field of vision.

In addition to studying the conditions that give us maximum efficiency, it is important to determine the lighting conditions and eye factors that cause discomfort. In fact, it might well be said that our problem in lighting at present is not so much how to see better as it is how to see with more comfort and with less damage to the general health on account of eye-strain. Any comparative study of the conditions producing discomfort necessitates a method of estimating discomfort. As stated earlier in the paper, our method of estimating discomfort is entirely distinct and separate from our method of studying efficiency. Time can not be taken here to go into details of either the method or of the results of this study. It will be sufficient to say that the effect of distribution of light and surface brightness, intensity, and quality are also being studied in their relation in the comfort as well as to the efficiency of the eye.

In conclusion, the writer wishes to point out that no one of the factors he has mentioned can be safely omitted in the search for the most favorable conditions of lighting. Nor can one be investigated and a correlation between it and the others be taken for granted. We have been content, heretofore, to base our conclusions with regard to the relation of a lighting system to seeing on the conventional visual acuity test. While this test may tell us something about the general level or scale of efficiency of the fresh eye, it can tell us nothing of loss of efficiency, because the muscles of the eye, although they may have fallen off enormously in efficiency, can under the spur of the will be whipped up to their normal power long enough to make the judgment required by the test. Moreover, it tells us nothing of the conditions that produce discomfort. In short, the general level or scale of efficiency of the fresh eye, loss of efficiency as the result of work, and the tendency to produce discomfort constitute three separably determinable moments, no one of which should be neglected in installing a lighting system.

C. E. FERREE

BRYN MAWR COLLEGE

## *CARL FUCHS*

MR. CARL FUCHS, the well-known entomologist, died on June 11, 1914, at his home in Alameda, California. He had attained the good age of 74 years, 6 months and 17 days, and was a native of Hanan, Frankfurt-am-Main, Germany, where he was born on November 25, 1839. His remains were cremated. He was always active, energetic and punctual in business, and was noted for his enthusiasm on all matters appertaining to his favorite study. His specialty was the Coleoptera, and up to the time of the earthquake and fire of 1906, he had the largest collection on the Pacific Coast. The loss of this—his life's work, with the exception of a few boxes which contained a genera collection—greatly depressed his spirit and ambition for a time. He rallied, however, and had by unceasing efforts up to the time of his death amassed another moderately large collection.

Mr. Fuchs was one of the most hospitable, kind and lovable of men, ever ready to aid amateurs or his younger colleagues, both as regards advice and material. The news of his death will be a shock to his numerous friends both in the United States and abroad.

His trade was that of a chaser and engraver,

at which he worked up to about three years ago. His work was always of the highest order. His neatness and exactness in the preparation of entomological material was unique and characteristic. It gained for him the appointment of assistant curator in the entomological department of the California Academy of Sciences, where he worked up to the time of his last illness. After the San Francisco disaster and while the academy was unsettled he received the appointment of preparateur and assistant in the entomological department of the University of California, where he was known by the students as Professor Fuchs. When the California Academy of Sciences was again ready for his services he returned to it.

He leaves a widow, Maria Fuchs, who was a typical and devoted helpmate, and who could even excel her husband in the care and mounting of the coleopterous Pselaphidæ.

In the death of Mr. Fuchs, one of the last of a group of the older entomologists has passed away; to this group belonged Frederick Blanchard, Samuel H. Scudder, Henry Ulke and Phillip R. Uhler. The younger entomologists of the Pacific Coast, many of whom were his intimate friends, have ever been stimulated and enthused by his earnestness and example. He was a member of the California Academy of Sciences, and also of the Deutsche Entomologische Gesellschaft of Berlin. It was he who organized the Pacific Coast Entomological Society and was its first president, a position which he held for several years. In his earlier years he was similarly connected with the Brooklyn Entomological Society, and contributed short articles and notes to its *Bulletin*. In 1882, he published a synopsis of the Lucanidæ of the United States.

Frank E. Blaisdell, Sr.

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### *ESTIMATES OF POPULATION*

The United States is now a country of 109,000,000 people, according to the bulletin containing the estimates of population for the years subsequent to the thirteenth census, soon to be published by Director William J. Harris, of the bureau of census, Department of Commerce. It was prepared under the supervision of C. S. Sloane, geographer.

As stated, the estimated population of the United States for July 1, 1914, will be 109,021,992. The population of the United States and its possessions in 1910 was 101,748,269; so there will have been an estimated gain of over 7,000,000 persons in a little more than four years. The corresponding estimated population of continental United States for July 1, 1914, is 98,781,324, as compared with the population of 91,972,266, as returned by enumerators, April 15, 1910. This bulletin also presents the estimates of population in 1910, 1911, 1912, 1913 and 1914, for the states and territories, and for cities which had 8,000 or more inhabitants in 1910.

Estimates of population are required primarily for use in the census bureau in calculating death-rates and per capita averages for years other than the census year. The so-called arithmetical method was adopted for computing these estimates. It is the simplest and it has been shown by experience to come nearer in accuracy in the majority of cases than any other formula. It rests on the assumption that the increase in population each year since the enumeration is equal to the annual increase from 1900 to 1910.

The bulletin presents in its several tables population data for the United States and its outlying possessions in 1910 and 1900, with estimates of the population July 1, 1914, 1913, 1912, 1911 and 1910. Similar data are also presented for the different states in the union. There is also presented a statement of white and colored population on April 15, 1910, together with estimates of the white and colored population as of July 1 for each of the years 1914, 1913, 1912, 1911 and 1910. These estimates, however, have been confined to the states having a considerable proportion of colored population, no estimate being presented for any state that did not have 50,000 or more colored inhabitants on April 15, 1910, or at least ten per cent. of its population colored.

The estimates of population for July 1,

1914, and the population April 15, 1910, for all states are as follows:

| State | Population Estimated: July 1, 1914 | Census: April 15, 1910 |
|---|---|---|
| Alabama | 2,269,945 | 2,138,093 |
| Arizona | 239,053 | 204,354 |
| Arkansas | 1,686,480 | 1,574,449 |
| California | 2,757,895 | 2,377,549 |
| Colorado | 909,537 | 799,024 |
| Connecticut | 1,202,688 | 1,114,756 |
| Delaware | 209,817 | 202,322 |
| District of Columbia | 353,378 | 331,069 |
| Florida | 848,111 | 752,619 |
| Georgia | 2,776,513 | 2,609,121 |
| Idaho | 395,407 | 325,594 |
| Illinois | 5,986,781 | 5,638,591 |
| Indiana | 2,779,467 | 2,700,876 |
| Iowa | 2,221,755 | 2,224,771 |
| Kansas | 1,784,897 | 1,690,949 |
| Kentucky | 2,350,731 | 2,289,905 |
| Louisiana | 1,773,482 | 1,656,388 |
| Maine | 762,787 | 742,371 |
| Maryland | 1,341,075 | 1,295,346 |
| Massachusetts | 3,605,522 | 3,366,416 |
| Michigan | 2,976,030 | 2,810,173 |
| Minnesota | 2,213,919 | 2,075,708 |
| Mississippi | 1,901,882 | 1,797,114 |
| Missouri | 3,372,886 | 3,293,335 |
| Montana | 432,614 | 376,053 |
| Nebraska | 1,245,873 | 1,192,214 |
| Nevada | 98,726 | 81,875 |
| New Hampshire | 438,662 | 430,572 |
| New Jersey | 2,815,663 | 2,537,167 |
| New Mexico | 383,551 | 327,301 |
| New York | 9,899,761 | 9,113,614 |
| North Carolina | 2,339,452 | 2,206,287 |
| North Dakota | 686,966 | 577,056 |
| Ohio | 5,026,898 | 4,767,121 |
| Oklahoma | 2,026,534 | 1,657,155 |
| Oregon | 783,239 | 672,765 |
| Pennsylvania | 8,245,967 | 7,665,111 |
| Rhode Island | 591,215 | 542,610 |
| South Carolina | 1,590,015 | 1,515,400 |
| South Dakota | 661,583 | 583,888 |
| Tennessee | 2,254,754 | 2,184,789 |
| Texas | 4,257,854 | 3,896,542 |
| Utah | 414,518 | 373,351 |
| Vermont | 361,205 | 355,956 |
| Virginia | 2,150,009 | 2,061,612 |
| Washington | 1,407,865 | 1,141,990 |
| West Virginia | 1,332,910 | 1,221,119 |
| Wisconsin | 2,446,716 | 2,333,860 |
| Wyoming | 168,736 | 145,965 |

| State | City | Population Estimated: July 1, 1914 | Population Census: April 15, 1910 |
|---|---|---|---|
| ALABAMA | Birmingham | 166,154 | 132,685 |
| CALIFORNIA | Los Angeles | 438,914 | 319,198 |
| | Oakland | 183,002 | 150,174 |
| | San Francisco | 448,502 | 416,912 |
| COLORADO | Denver | 245,523 | 213,381 |
| CONNECTICUT | Bridgeport | 115,289 | 102,054 |
| | Hartford | 107,038 | 98,915 |
| | New Haven | 144,505 | 133,605 |
| DIST. OF COLUMBIA | Washington | 353,378 | 331,069 |
| GEORGIA | Atlanta | 179,292 | 154,839 |
| ILLINOIS | Chicago | 2,393,325 | 2,185,283 |
| INDIANA | Indianapolis | 259,413 | 233,650 |
| KENTUCKY | Louisville | 235,114 | 223,928 |
| LOUISIANA | New Orleans | 361,221 | 339,075 |
| MARYLAND | Baltimore | 579,590 | 558,485 |
| MASSACHUSETTS | Boston | 733,802 | 670,585 |
| | Cambridge | 110,357 | 104,839 |
| | Fall River | 125,443 | 119,295 |
| | Lowell | 111,004 | 106,294 |
| | New Bedford | 111,230 | 96,652 |
| | Springfield | 100,375 | 88,926 |
| | Worcester | 157,732 | 145,986 |
| MICHIGAN | Detroit | 537,650 | 465,766 |
| | Grand Rapids | 123,227 | 112,571 |
| MINNESOTA | Minneapolis | 343,466 | 301,408 |
| | St. Paul | 236,766 | 214,744 |
| MISSOURI | Kansas City | 281,911 | 248,381 |
| | St. Louis | 734,667 | 687,029 |
| NEBRASKA | Omaha | 133,274 | 124,096 |
| NEW JERSEY | Camden | 102,465 | 94,538 |
| | Jersey City | 293,921 | 267,779 |
| | Newark | 389,106 | 347,469 |
| | Paterson | 134,305 | 125,600 |
| | Trenton | 106,831 | 96,815 |
| NEW YORK | Albany | 102,961 | 100,253 |
| | Buffalo | 454,112 | 423,715 |
| | New York (including) | 5,333,537 | 4,766,883 |
| | Bronx borough | 529,198 | 430,980 |
| | Brooklyn borough | 1,833,696 | 1,634,351 |
| | Manhattan borough | 2,536,716 | 2,331,542 |
| | Queens borough | 339,886 | 284,041 |
| | Richmond borough | 94,043 | 85,969 |
| | Rochester | 241,518 | 218,149 |
| | Syracuse | 149,353 | 137,249 |
| OHIO | Cincinnati | 402,175 | 363,591 |
| | Cleveland | 639,431 | 560,663 |
| | Columbus | 204,567 | 181,511 |
| | Dayton | 123,794 | 116,577 |
| | Toledo | 184,126 | 168,497 |
| OREGON | Portland | 260,601 | 207,214 |
| PENNSYLVANIA | Philadelphia | 1,657,810 | 1,549,008 |
| | Pittsburgh | 564,878 | 533,905 |
| | Reading | 103,361 | 96,071 |
| | Scranton | 141,351 | 129,867 |
| RHODE ISLAND | Providence | 245,090 | 224,326 |

| State | City | Population | |
|---|---|---|---|
| | | Estimated: July 1, 1914 | Census: April 15, 1910 |
| Tennessee | Memphis | 143,231 | 131,105 |
| | Nashville | 114,899 | 110,364 |
| Texas | Dallas | 111,986 | 92,104 |
| | San Antonio | 115,063 | 96,614 |
| Utah | Salt Lake City | 109,530 | 92,777 |
| Virginia | Richmond | 134,917 | 127,628 |
| Washington | Seattle | 313,029 | 237,194 |
| | Spokane | 135,657 | 104,402 |
| | Tacoma | 103,418 | 83,743 |
| Wisconsin | Milwaukee | 417,054 | 373,857 |

The preceding list shows the estimates of population for July 1, 1914, and the population in 1910, for cities having an estimated population July 1, 1914, of at least 100,000.

## *SCIENTIFIC NOTES AND NEWS*

Dr. David Starr Jordan, chancellor of Leland Stanford University, has been elected president of the National Education Association.

Dr. F. W. Dyson, astronomer royal of Great Britain, has been elected a correspondent of the Paris Academy of Sciences, in the section of astronomy.

On May 13, the Daly medal for geographical research of the American Geographical Society, which had been awarded by the council to Dr. A. Penck, professor of geography, Berlin, was formally presented to him by the Hon. James W. Gerard, ambassador of the United States to Germany, at the embassy in Berlin.

The trustees of the American Medicine Gold Medal Award announce that the medal for 1914 has been conferred upon Dr. George W. Crile, of Cleveland, O., as the American physician, who, in their judgment, has performed the most conspicuous and noteworthy service in the domain of medicine and surgery during the past year.

The London Mathematical Society has awarded its de Morgan medal to Sir Joseph Larmor of the University of Cambridge.

Professor W. F. Bruck has received the Askenasy prize of the Senckenberg Scientific Society of Frankfort for his botanical researches.

Dennison University has conferred the degree of LL.D. on Dr. Richard C. Maclaurin, president of the Massachusetts Institute of Technology; Dr. Ernest F. Nichols, president of Dartmouth College; Dr. W. H. P. Faunce, president of Brown University, and Professor William E. Castle, of Harvard University.

On the occasion of the tercentenary of the founding of Groningen University the following honorary degrees have been conferred: Doctor of Medicine on Sir Edward Schaefer, Edinburgh, and Professor J. N. Langley, Cambridge; Doctor of Geology and Mineralogy on Dr. A. L. Day, of the Carnegie Institution; Doctor of Botany and Zoology on Professor S. J. Hickson, Manchester.

At its recent commencement the Birmingham Medical College and Graduate School of Medicine of the University of Alabama conferred the honorary degree of doctor of medicine upon Dr. A. Richard Bliss, Jr., professor of chemistry and pharmacology in the university.

The University of Toronto has conferred the degree of doctor of science on Mr. Frank T. Shutt, Dominion chemist and assistant director of experimental farms.

Professor James Geikie, professor of geology in the University of Edinburgh since 1882, when he succeeded his brother, Sir Archibald Geikie, is about to retire from the active duties of the chair.

Professor T. R. Lyle, F.R.S., is shortly to resign the professorship of natural philosophy in the University of Melbourne.

Dr. Alois Riehl, professor of philosophy at Berlin, has given the seventeen thousand marks presented to him on his seventieth birthday for the establishment of Dozentenhaus, intended to be a hall of residence for lecturers at the university.

At the request of many organizations throughout Louisiana the Treasury Department has ordered Surgeon-General Rupert Blue, of the Public Health Service, to take

charge of the bubonic plague extermination measures at New Orleans.

GEORGE CHANDLER WHIPPLE, Gordon McKay professor of sanitary engineering at Harvard University, has been appointed by the Board of Estimate and Apportionment of the City of New York a member of the committee on building districts and restrictions.

DR. JOHN H. FINLEY, New York state commissioner of education, has sailed for Europe to represent the United States at the International Conference on Education to be held at The Hague. Dr. Finley will spend some time in Germany investigating educational administration in Berlin and other large cities.

MESSRS. ALLEN, Brewster, Chapman, Dwight, Jos. Grinnell, Merriam, Nelson, Oberholser, Palmer, Richmond, Ridgway and Stone have been appointed a "committee on classification and nomenclature of North American birds" by the American Ornithologist's Union.

MR. W. O. REDMAN KING, lecturer in zoology at the University of Leeds, has been appointed Ray Lankester investigator at the Marine Biological Laboratory in Plymouth, in succession to Professor E. L. Bouvier, of Paris. The investigator is required to undertake research work of his own choosing at the laboratory for a period of five months, the emolument being £70.

DURING the third and fourth weeks of June Professor C. J. Keyser, of Columbia University, delivered a series of three lectures on science and religion at the University of Montana.

DR. WALTHER NERNST, professor of physical chemistry at the University of Berlin, has spent six weeks giving lectures at the University of La Plata. Plans are being made for an exchange of professors between the Prussian and Argentine governments.

IN memory of their father, Sir W. Lawrence, F.R.S., and of their brother, Sir Trevor Lawrence, the Misses L. E. and M. W. Lawrence have presented £4,000 to the Royal Society in trust to devote the interest to the furtherance of research into the cause and cure of disease in man and animals in such manner as the president and council may from time to time determine.

PROFESSOR SETH EUGENE MEEK, assistant curator of zoology at the Field Museum of Natural History, Chicago, died on June 6 of illness brought on by exposure during an expedition in Mexico. Professor Meek, who was fifty-five years of age, was an authority on fishes and reptiles.

MR. THOMAS THORP, of Manchester, known in connection with his transparent celluloid replicas of Rowland's and other diffraction gratings, died on June 13.

THE death is announced of Professor Karl Dammann, until recently president of the veterinary school of Hanover.

THE archeologist, M. Georges Perrot, permanent secretary of the Paris Academy of Inscriptions and Belles Lettres, died on June 30.

THE U. S. Civil Service Commission announces an open competitive examination for positions in the Children's Bureau, Department of Labor, Washington, D. C., as follows: Expert on sanitation at a salary of $2,800; social science expert at a salary of $2,000, and statistical expert at a salary of $2,000. These positions are open to both men and women.

THE New York Civil Service Commission announces an open competitive examination on July 28 for analytical chemist for the State Reservation Commission, Saratoga Springs, with a salary of $1,200, and an examination for an assistant chemist in the state department of agriculture at a salary of from $800 to $1,200.

THE laboratory for ship and tropical diseases at Hamburg, erected and equipped at a cost of about $600,000, of which Professor Nocht is director, was recently formally opened.

AN institute for the history of medicine has been established at the University of Vienna. It has acquired within a year a library of 3,000 volumes and a large collection of manuscripts, letters and instruments.

Among recent additions to the Natural History Branch of the British Museum, *Nature* notes the following specimens as of general public interest: The skeleton of the thoroughbred stallion, "St. Simon," presented by the Duke of Portland, which is not yet on exhibition, but is, we understand, to be placed alongside the skeleton of his son, "Persimmon," presented by his late Majesty King Edward VII. "St. Simon" was foaled in 1881, and was never beaten on the turf. Another interesting skeleton is that of the Egyptian Eocene two-horned ungulate, Arsinoëtherium, which has just been set up in the fossil mammal gallery. This skeleton is a restoration in plaster, but as nearly all the elements have been modelled from actual bones, it is practically as good as if original. As mounted, the skeleton is about 11½ feet in length from the muzzle to the root of the tail, a striking feature being the very wide interval between the limbs of opposite sides. The precise affinities of this strange beast are still unknown. In the upper mammals gallery the attention of the public has been riveted on a gigantic specimen of the eastern race of the gorilla (*Anthropopithecus gorilla beringeri*), from the neighborhood of Lake Tanganyika, recently presented by the Rowland Ward trustees. In addition to its huge size, this race is characterized by the great development of long black hair on the head, shoulders and buttocks, and the restriction of the gray band on the back to the loins. On entering the museum the visitor should inspect a segment of the trunk of a fossil conifer from the Trias of Arizona, presented by Mr. Arthur Pearson, and placed by one of the pillars on the right side of the hall. This specimen, which weighs about 2½ tons, has an adventitious interest on account of the brilliant colors presented by the silicified wood, as is admirably shown in the polished upper surface.

Deposits of cerusite or lead carbonate near Isle, in the northeastern part of Custer County, Colo., were examined last year by Mr. J. F. Hunter, geologist of the U. S. Geological Survey, and his report has just been published. The deposits extended in a narrow belt for several miles along the foot of the steep western slopes of the Wet Mountains, where faulting and crushing have produced conditions favorable to ore deposition. The lead carbonate has been deposited in zones or shoots, filling joint planes and cracks in crushed and altered granite. Investigations show that the carbonate ores have probably resulted from the oxidation of galena (lead sulphide), which should be found at greater depths than have yet been attained by mining or drilling. Only the upper portion of the ore deposits, known as the oxidized zone, has been opened. Two important ore zones, one at the Terrible mine and the other at Lead Hill, on the Wild Girl and High Kicker claims, were visited, and a trip was made over Lead Hill into Parker Gulch, revealing considerable cerusite strewn over the hills as float, so that the existence of additional bodies and zones of cerusite seems probable. The mines of this district have been worked intermittently since 1884 and have produced nearly $1,000,000 worth of lead. It is reported that the ores averaged from 5 to 8 per cent. of lead and were capable of being concentrated to a product running from 60 to 70 per cent. The ores thus far mined contain a small amount of silver but no zinc, arsenic, antimony or sulphur.

The ancient vegetation which grew in South Carolina and Georgia during Upper Cretaceous and Eocene time—or, as geologists state, at least several million years ago—has been made the subject of an exhaustive investigation by Edward W. Berry, of the Johns Hopkins University, a report on which has just been published by the U. S. Geological Survey as Professional Paper 84. The earlier of these fossil floras, that of the Upper Cretaceous, embraces nearly one hundred species of wholly extinct plants, and as the majority of them are believed to have been trees or shrubs, it is interesting to compare them with the vegetation now living in the same area. In addition to the sequoia or "big tree," now confined to the Pacific coast, there were three kinds of araucarias or Norfolk Island pines, which at the present time live only in South America and Australia; a pine with the leaves in clus-

ters of three as in the living pitch pine, and a number of cypress-like trees which were once widely spread over the world but are now extinct. There was also a fan palm with very large leaves, which was perhaps the remote ancestor of the palmetto. Among the deciduous trees there were wax berries (*Myrica*) of two kinds, walnuts, many willows with long, narrow leaves, oaks of the type of the living black oak, fig trees of many kinds, and several magnolias. Among the smaller trees or shrubs there were soapberries (*Sapindus*), bittersweet, sumac, laurels and cinnamons nearest to forms now confined to the Old World, and three kinds of eucalyptus, the living representatives of which are now native to Australia. The remote ancestors of the persimmon were also present, as well as a number of other kinds that are without vernacular names. From the careful study of this ancient flora which has been preserved in fossil form in the rocks, it has been possible to draw certain tentative though apparently reasonable conclusions as to the conditions which prevailed in South Carolina and Georgia when it was growing. These indicate that shallow seas extended inland over 100 miles from the present Atlantic coast; that there was a considerable elevation and relief of the Piedmont area to the west; that the river gradients were high and the streams numerous and more or less torrential in character; and that there were swamps along the lower courses of the streams. The fossil plants indicate that there was a mild though not a strictly tropical climate, without marked seasonal changes—in fact, there is no evidence that frost occurred. The rainfall was abundant, as shown by the general character of the flora, as well as by certain features observed on some of the leaves and known as the "dripping points." The later or Eocene flora has been found only in the state of Georgia and is relatively small, as it numbers only 17 species. All the species represent northward migrants along the Eocene seacoast from equatorial America. They include West Indian palms, plants of the wonderful mangrove swamps that skirt the tidal shores in the tropics of both hemispheres, and remains of the golden fern whose present-day descendants lead a gregarious existence in the coastal swamps of the torrid zone. All these Eocene plants are types of the Florida keys, Antillean islands and Central American shores and clearly indicate that in middle Eocene time the climate of Georgia was much warmer than it was either during the Upper Cretaceous epoch or at present.

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## *UNIVERSITY AND EDUCATIONAL NEWS*

ANNOUNCEMENT has been made by Yale University that members of the Lauder family of Pittsburgh, Pa., and of Greenwich, Conn., were the donors of the $400,000 fund recently pledged to the Yale Medical School. It will be known as the "Anna M. R. Lauder Fund," in memory of the late Mrs. George Lauder. The donors make the stipulation that a memorial professorship in public health be established for the benefit of the state of Connecticut.

A GIFT of $13,750 has been made by Mr. D. D. Stewart, of St. Albans, to the University of Maine, to discharge the remaining indebtedness on Stewart Hall, the College of Law building in Bangor.

THE merging of the Starling-Ohio Medical College with Ohio State University will become effective next September. Buildings and equipment valued at approximately $250,000 will be added to the university. No state aid will be asked at present, it was announced, although it had been previously planned to ask the legislature for an appropriation of $25,000. Beginning with the session of 1914–15, the medical college will require for entrance one year's work of college standard, which must include instruction in chemistry, physics and biology.

HERR CAESAR SCHOLLER, of Zurich, has made an additional gift of 15,000 Marks to the Philogenetic Museum at Jena, to which he had previously given 115,000 Marks.

DR. B. L. ARMS has been appointed professor of preventive medicine in the medical department of the University of Texas.

In the department of geology of Northwestern University the following appointments have been made, to take effect on September 1, 1914: Joseph E. Pogue, of the U. S. Geological Survey, to be associate professor of geology and mineralogy; William H. Haas, of the University of Chicago, to be instructor in geology and geography; Henry R. Aldrich, of the Massachusetts Institute of Technology, to be instructor in mining and metallurgy; John R. Ball, of Northwestern University, to be assistant in geology.

Mr. F. E. E. Lamplough, of Trinity College, has been appointed demonstrator of chemistry in the University of Cambridge.

Mr. D. T. Gwynne-Vaughan, professor of botany in the Queen's University, Belfast, has been appointed to the professorship of botany at University College, Reading, vacant by the resignation of Dr. Frederick Keeble, F.R.S., who has been appointed director of the Experiment Station and Gardens of the Royal Horticultural Society at Wisley.

Dr. Niels Bohr, of the University of Copenhagen, has been appointed reader in mathematical physics in the University of Manchester.

Dr. August Gutzmer, professor of mathematics at Halle, has been elected rector of the university for the coming year.

Dr. Eugene Korschelt, professor of zoology and comparative anatomy at Marburg, has been called to Leipzig, but has decided to remain at Marburg.

## *DISCUSSION AND CORRESPONDENCE*

### LIGHTNING FLASHES

To the Editor of Science: If often becomes necessary for me as editor to refer special questions that arise to those who are better versed in the knowledge of some special branch of physics.

I should be glad if any one of your readers who has considered the question of the oscillatory character of lightning would give me a short report, from either a theoretical or an observational point of view, as to what is known on this subject, or his own experience therein. An elaborate paper on this subject was published in the *Meteorologische Zeitschrift* for September, 1913, by Professor Dr. Josef Mayer, of Freising, Bavaria, defending the conclusion that although the lightning flash is frequently oscillatory, yet it is also often of a complicated nature in which every variety of the discharge can occur, namely, both a preliminary, a principal, a partial and an after discharge; partial discharges of a simple nature as shown by Feddersen, or of a double nature as shown by Walter; moreover, the discharge of thunder-clouds may also, under certain conditions, be continuous, but under others, oscillatory or again pulsatory.

This subject is one that interests every scientist who is subject to danger from lightning. I hope to receive responses from electricians and physicists whose experiments and experience tend to elucidate the subject.

Cleveland Abbe
U. S. Weather Bureau

### A NEW FORM OF COLLECTING PIPETTE

The pipette described below has proved very useful to the writer. It is made from a calcium chloride tube about 200 mm. long and the ordinary 50 c.c. rubber bulb commonly used with the larger rubber-bulb pipettes. Both are stock articles and may be readily procured from laboratory supply houses. The calcium chloride tube used in the pipette figured consists of a glass bulb about 35 mm. in diameter blown in a glass tube of 16 mm. diameter and about 120 mm. long. This tube required to be heated over a flame and drawn out to the desired diameter for the pipette mouth. From the opposite end of the glass bulb there extends a tube about 6 mm. in diameter suitable for attachment of the rubber bulb.

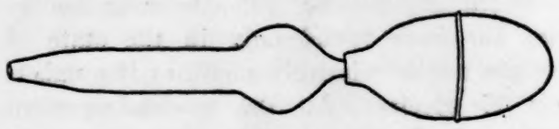

Fig. 1.

This form of pipette may be used in handling in water any small or delicate object up to six or eight mm. in diameter. (Not

quite so large a mouth could be utilized if the pipette were to be used in liquids lighter than water.) It is a most useful collecting convenience. In places where a small net could not be used because of stones or other debris and in handling objects liable to injury in a net the writer has found it almost indispensible. The capacity of the rubber bulb and the large mouth of the pipette make it possible by means of a sudden suction to catch small animals too quick to be taken in a small gauze net. The glass bulb retains all the sucked-in water, enabling one to see what has been taken and obviating the difficulty of losing or mutilating a choice specimen by getting it into the rubber bulb. The pipette is not overfragile and is short and convenient for slipping into the pocket or collecting case. It is also more convenient to use than the long pipette in common use.

The calcium chloride tubes are made in various sizes. For a smaller pipette a rubber bulb of 25 c.c. capacity and a calcium chloride tube 150 mm. long may be used. The cost of the pipette is slight.

ARTHUR M. BANTA
STATION FOR EXPERIMENTAL EVOLUTION

## IS MELANISM DUE TO FOOD?

IT is a well-known fact that occasional dark-colored individuals occur among wild animals of various kinds. Once in a while a pure black beaver is caught. Fur traders sometimes pick up skins of mink, otter, marten and other animals which are coal black. These skins are especially valuable. Perhaps the best known instance of dark specimens occurring in a species ordinarily light in color is that of the silver or black fox, which may be one in a litter of common red foxes.

This occurrence of dark animals is called "melanism," but so far science has failed to ascertain the cause. It is my purpose in this article to call attention to some facts which may or may not throw some light on the subject, but which seem to me to be at least suggestive.

Northern Minnesota has been a great fur-producing region ever since the Hudson Bay Company established posts here at the headwaters of the St. Lawrence, the Mississippi and the Red River of the North. We should expect, and the fur traders actually get choice furs from this cold, high, heavily wooded land of lakes. The high grade of furs obtained in northern Minnesota is well known to the trade; the value of the annual catch, over a million dollars, is something less widely known.

It is commonly supposed that the relative proportion of different kinds of fur caught in the state runs along fairly constant year after year. This is not the case for two reasons. A series of years may be favorable for the increase of a species, resulting for a time in an abnormally heavy catch of that animal. As an instance of this, we cite the Canadian lynx, which increases with the abundance of the snowshoe rabbit, and suffers or migrates at intervals when its food supply has been seriously reduced by the dying off of the rabbits from the so-called "rabbit plague." Perhaps a better instance is that of the muskrat, which may increase because of several winters during which ice and water conditions are favorable to its "wintering over." The other reason is that which gives rise to this article. A species like the red fox may suddenly show an unusually strong tendency to vary from its type.

Ordinarily there are caught annually in northern Minnesota somewhere in the neighborhood of fifteen hundred red foxes. Of this number of skins, we venture to guess that, for the five years preceding the winters of 1911 and 1912, not more than ten each year were sold as black or silver foxes, and not over forty as cross foxes. The winter of 1911–12 saw a marked increase in the number of high-grade fox skins brought in to the posts, and there was a still further increase in 1912–13. In the Rainy River watershed, especially, it seemed as if about one fifth of the foxes caught last winter were either dark, silver or cross foxes. This winter, 1913–14, the percentage of these high-grade color phases is even higher.

During the past three years there has been an abundance, amounting almost to a plague, of mice (white-footed wood-mice) in the

woods of northern Minnesota, particularly in the Rainy River country. These have been years of abundance of the snowshoe rabbit also. The latter have been so numerous that they did great damage by girdling small trees, and the quantity of brush they ate off was simply amazing. As one of our rangers put it, "The rabbits in my district have eaten up the brush this winter, and if they increase any more they'll probably start logging next year." The rabbits are rapidly dying off in certain districts this year.

Ordinarily the black fox is a larger and stronger individual than his red brother. This in itself may have significance.

Is it unreasonable to assume, in view of the foregoing facts, that a plenteous supply of the food most palatable to the red fox has some influence at least in strengthening the tendency of this animal to produce dark-colored specimens, in other words to cause melanism?

It is true that some of the increase in the proportion of dark foxes may be due, and probably is due, to the coming in of dark specimens from more northern localities in Canada, following up the abundant mouse and rabbit crop. No locality, even in any of the adjoining portions of Canada, however, has a much higher relative proportion of silver foxes than is ordinarily found along the Rainy River.

In view of the farming experiments now under way with dark foxes, I should welcome a discussion of this point, which is coming to have economic importance.

Wm. T. Cox
State Forester of Minnesota

## SCIENTIFIC BOOKS

*Igneous Rocks.* By Joseph P. Iddings. Vol. II., Description and Occurrence. New York, John Wiley & Sons. 1913. 8vo. Pp. xi + 685, 20 figures and maps.

The first volume of Iddings's treatise on igneous rocks, dealing in the abstract with their composition, texture, mode of occurrence, origin and classification, appeared in 1909 and was reviewed in Science, Vol. XXX., pp. 408–411, 1909. The work is now complete with this second volume, which presents a systematic description of the rocks and a review of their known distribution and association in all parts of the world. This volume is of the greatest importance to petrographers, for in no other work in any language is there such an extensive and judicial analysis of the vast literature of petrography. Iddings has succeeded wonderfully in his difficult task, but it is clear that the time is rapidly approaching when each of the great subjects, systematic description, mode of occurrence and world distribution, of igneous rocks, must be fully treated by itself, unrestricted by the limitations of a general work.

The markedly original features of Iddings's book make it unusually desirable that the reader should familiarize himself with the author's purpose and plan which are outlined in the preface. From this statement it may be well to quote certain passages, as follows:

"Since the fundamental need of petrology at this time is a correct understanding of the constitution or composition of igneous rocks it has been the purpose of this treatise to emphasize the chemical and mineral characteristics in their description. For this reason chemical analyses of rocks, transformed into possible mineral compounds, have been made the foundation on which the systematic description of igneous rocks has been constructed; that is, they have been employed as a basis of definition and of correlation of rocks that differ in texture and to a greater or less extent in apparent or actual mineral composition. Igneous rocks have been treated as though they were portions of *continuous series of mixtures* of mineral compounds varying in numerous ways, and not as specific though somewhat ill-defined compounds possessing individual entities to be reckoned with in their grouping or classification" (page iii).

"The purpose of the second part of the book has been to present a brief sketch of the distribution of igneous rocks throughout the earth so far as now known, in order to lay the foundation for a study of possible petrographical provinces in different regions, since much investigation of these rocks in all re-

gions is needed before definite conclusions may be reached regarding the actual nature of such provinces and *their significance with respect to the dynamical history of the earth*" (page v).

Part I. of the volume, devoted to the systematic description of igneous rocks, is introduced by an important review of their characters and the difficulties attending their systematic treatment. It is pointed out that the rock type "is subjective, inherent in the petrographer, not the rock." Igneous rocks form a continuous series, hence their systematic treatment must be arbitrary as to divisions, but it does not follow that all methods of classification are equally good or bad.

One of the most important features of Iddings's work is the influence it seems destined to have on the development of systematic petrography. That the user of the book may fully appreciate this it seems desirable to survey the present situation of the science, on lines not especially emphasized by the author.

The current system of petrography, called the qualitative system by Iddings, classifies igneous rocks chiefly by their important mineral constituents. For granular rocks there is more and more effort to recognize the quantitative development of certain minerals, while nephelite, leucite and others are given great weight, almost regardless of their abundance. In porphyritic rocks, however, especially if micro-, crypto- or hypocrystalline, the phenocrysts alone are given classificatory value in many cases (Rosenbusch system). The groundmass is practically ignored by many petrographers in naming rocks.

The fundamental importance of chemical composition of igneous rocks is universally recognized. Mineral composition is an expression of the chemical, though less directly than once supposed. The natural ambition of the petrographer to express chemical composition in his mineralogical classification is frustrated by the fact that he can not ascertain the mineral composition of many rocks at all accurately and by the variable chemical composition of most rock-making minerals. Only the inherent and perhaps insuperable difficulties of the problem have prevented the formulation, before now, of a satisfactory mineralogical classification, and it is equally certain that efforts to improve that system will go on with at least some measure of success.

The quantitative system, of which Iddings is one of the authors, permits an accurate classification of igneous rocks, desirable for many purposes, wherever the chemical composition can be ascertained. It is self-evident, however, that the data for the quantitative classification of the vast majority of rocks can not be obtained and that another system of general applicability must be used concurrently with it. The most evident and familiar character-giving feature of igneous rocks is their mineral composition, and it seems clear that some improved form of the current system must always remain the one for general purposes. But to satisfy the natural demands of scientific men this system must be given much greater precision and consistency than it now possesses. The approach to a real system must come by introducing greater precision in definition, using quantitative mineral composition as far as practicable and expressing in the most feasible manner a correlation between chemical and mineral factors. The petrographic system of the future for general purposes will be an evolution from the unsatisfactory one now current through the trying out of many propositions and a selection of the best.

A quantitative factor is now being introduced into the mineralogical system in various ways. Monzonite, granodiorite and other major terms illustrate this, and a large number of new rock names of lesser importance have been recently proposed in recognition of the abundance or prominence of certain minerals. But this development is not controlled or guided by definite rules or principles, and until such have been adopted increased confusion must be the result.

Probably all petrographers are ready to welcome a practical and logical proposition to modify or control the mineralogical classification by chemical data. But it is evident that the application of such a scheme implies chem-

ical analysis of a rock which is to be classified or else an ability on the part of the petrographer to make a satisfactory comparison between the rock in hand and a similar type which has been analyzed. The proper use of such a system will be beyond the powers of many who now essay to name rocks. Probably some petrographers will object to Iddings's propositions as impossible of application by many who now endeavor to use the current system. But increasing precision in the system in any direction must have the same effect in some degree, and the development of petrography can not long be held back for the sake of a simplicity which can be maintained only at the expense of accuracy and efficiency.

Chemical data can be logically applied to the development of the mineralogical system only on the basis of our knowledge of the relation between chemical and mineral composition afforded by the several thousand rocks of which good analyses are now available. This relation has been studied by means of the significant molecular ratios between silica and bases or between various bases or groups. Osann's work is preeminent in this direction. His ratios and triangular diagrams on which they may be plotted express clearly certain chemical characteristics of igneous rock groups. But the application of such data to the revision of systematic mineralogical classification is a very complex problem the solution of which has not been attempted as yet.

Another means of expressing relations between chemical and mineral composition is the norm of the quantitative system, and Iddings's book will always be cited in the literature of systematic petrography as notable for its well-thought-out and far-reaching plan to reconstruct the qualitative or mineralogical system on the same principles which underlie the quantitative classification. If it is practicable to develop the mineralogical system on these principles, this is a first, long step forward in its evolution, to be followed by many other improvements suggested by experience. The reviewer's opinion as to the success of this attempt is naturally subject to the charge of prejudice, hence he contents himself in pointing out the great importance of Iddings's systematic propositions, whether they are finally adopted or not. They deserve the most careful, unbiased attention of petrographers in any case. If it proves to be practicable to develop the mineralogical system in the way proposed, it will then be brought into desirable harmonious relations with the quantitative system.

In Volume I. of "Igneous Rocks" Iddings presented his modification of the "Qualitative Mineralogical Classification" in the usual tabular form. A quantitative element is made prominent here by establishing five major divisions based on the dominance of I., quartz; II., quartz and feldspar; III., feldspar; IV., feldspar and lenads; V., lenads. The character of the dominant feldspar and the abundance or subordinate part of the ferromagnesian minerals gave subdivisions of the larger ones. While the lines of this scheme were not made precise, they served to divide many rock groups or varieties of current usage.

The underlying idea in this scheme is clear, but the detail with which it is worked out in Volume II. suggests an evolution in the author's mind. For instance, the ultra-basic rocks were not separated as a distinct group in Volume I., but now they appear as Division 6, and the way in which factors of the quantitative system are applied to give precision to the new scheme is illustrated by the statement that Division 6 embraces the rocks of Classes IV. and V. of the quantitative system. Iddings's first systematic division is actually by the amount of normative salic and femic molecules, into two groups, one corresponding to Classes I., II. and III., and the other to Classes IV. and V., of the quantitative system.

Divisions 1–5 are bounded by sharp lines determined by normative quartz, feldspar and lenads, the same relation by which orders are formed in Classes I., II. and III. in the quantitative system. The relative amount of mafic (ferromagnesian) and felsic minerals is used to make two subdivisions in each of these five major divisions.

The feldspathic rocks of divisions 2, 3 and 4 are each divided into three groups by the rela-

tive importance of the alkali and lime-soda feldspars. For aphanitic and glassy rocks this is determined from the norms, from which the average composition of the lime-soda feldspar can be calculated. Distinctions between potash and soda-rocks are also made.

The granular or phaneritic rocks are treated on the assumption that in most cases their mineral composition can be approximately determined. The aphanitic and glassy rocks which are chemical equivalents of the phanerites are classed with them, and their equivalence is determined through the norms. The limits of divisions in the quantitative system being vague, Iddings has assigned boundaries by quantitative factors which are the same as or similar to some of those used in the quantitative system. This involves restricting and redefining of many current terms, but where an old group name, such as andesite, is in question, Iddings has proposed new names for certain new divisions of the larger and older group.

While most of the names in current use are retained, Iddings gives precision to many of them, and supplements them by many new ones. As he has been guided by definite principles, several of which are new in their application to mineralogical systems, Iddings has practically made a new petrographic system. The reviewer believes that a large proportion of the new propositions will be welcomed by most petrographers of wide acquaintance with igneous rocks as corresponding, at least approximately, to changes in the old system which they have long regarded as necessary.

The way in which Iddings has subdivided older groups and supplied new terms may be illustrated by a few examples. Three kinds of dacite are recognized, each characterized by its average or normative plagioclase. Oligoclase dacites are called *ungaite;* those with andesine are called *shastaite,* and those with labradorite, *bandaite.* Oligoclase andesite is distinguished from andesite proper as *kohalaite,* while andesine basalt is called *hawaiite,* as distinct from basalts of labradorite feldspar.

A very valuable feature of the book is the 71 tables of chemical analyses of rocks (nearly 1,100 in all) arranged to show the composition of the new systematic divisions. The norm and quantitative classification of each rock are also given, and a general correlation of the mineralogical and quantitative systems is clearly expressed by the tables. Many diagrams also serve to show the relations of the two systems.

Part II. of this volume is a review of what is known concerning the occurrence and distribution of igneous rocks. It is based on personal examination of the extensive literature cited, and the magnitude of the task of preparation for this discussion will be appreciated only by those who have made some similar study of original sources. This is not a theoretical discussion of petrographical provinces, but an attempt to present the facts of our present very imperfect knowledge of the geographical distribution of igneous rocks. It is significant that Iddings, after this review, concludes that "it is too soon to attempt to define the area of any petrographical province. The data are insufficient for a complete definition or description of any one province . . ." (p. 351).

The distribution of rocks is presented by means of maps of continental areas and a systematic review of the rocks described from various districts.

The discussion begins with the rocks of North America as they occur in large provinces. Following the geographical treatment is a preliminary discussion of petrographic provinces suggested and a description of their individual characteristics, illustrated by diagrams.

The chemical composition of rocks of certain areas is shown by 65 tables containing 1,260 analyses, giving norms, etc., as in tables of the systematic part.

WHITMAN CROSS

*Allen's Commercial Organic Analysis.* Vol. VIII. Fourth edition. Edited by W. A. DAVIS and SAMUEL S. SADTLER. Philadelphia, P. Blakiston's Son & Co. 1913. Pp. x + 696. Price, $5.00 net.

Allen's "Commercial Organic Analysis," in

its successive editions, has enjoyed a widespread vogue in the United States, especially among chemists confronted with the necessity of examining a great diversity of products regarding which they did not always possess first-hand information. Every analyst feels the need, at times, of suitable reference books and dependable descriptions of tested methods. Certain manuals like the Neubauer-Huppert "Analyse des Harns" and the Hoppe-Seyler-Thierfelder "Handbuch" have received a hearty reception year after year because of the care and accuracy with which they were evidently compiled and because of the helpful guidance which they offered in the selection of suitable procedures. The chief criticism of many laboratory handbooks lies in the careless way in which they are edited, the lack of critique in the selection of methods of analysis; in fact, they frequently bear the earmarks of routine book-making by ambitious individuals who have little first-hand experience or broad acquaintance with the literature of the subject.

Every essay in the special field of organic analysis covered by Allen's Volume VIII. must to-day compete with a number of more pretentious reference works, such as Abderhalden's "Arbeitsmethoden," Leach's "Food Analysis," etc. These are supplemented by many smaller monographs. The only justification for a new competitor therefore lies in a high degree of excellence or in some unusual adaptation to hitherto uncovered domain. The problems of biochemical analysis in relation to "commercial" products are still far from a satisfactory solution in many respects. The conventional methods are in many cases somewhat empirical rather than strictly scientific; and the results furnish at best helpful approximations. Some of the names of the collaborators on the new Volume VIII. of Allen's series at once justify the reader in expecting a useful book. Its subdivisions are provided for as follows: Enzymes, by E. Frankland Armstrong; The Proteins and Albuminoid Substances, by S. B. Schryver; Proteins of Plants, by E. Frankland Armstrong; Proteins of Milk, by L. L. Van Slyke; Milk, by Henry Leffmann; Milk Products, by Cecil Revis and E. Richard Bolton; Meat and Meat Products, by W. D. Richardson; Digestion Products of the Proteins, by S. B. Schryver; Hæmoglobin and Its Derivatives, by John Addyman Gardner and George Alfred Buckmaster; Albuminoids or Scleroproteins, by Jerome Alexander; Fibroids, by W. P. Dreaper.

To many it may seem like a trivial performance on the part of a reviewer to refer to minor defects—omissions or errors—in a notice of this character. Every book has inevitable mistakes, we are assured; and to point them out is often looked upon as a sort of gratuitous effort that smacks of the mediocre. Perfunctory accounts of new books are easily prepared. However, it is only by a painstaking examination that one can ordinarily form a satisfactory estimate of the value of descriptions which depend upon novelty and accuracy of detail for their superior usefulness.

The new Allen, Volume VIII., presents a combination of historical and descriptive text with analytical directions for practical work. Much of it is well prepared, taking into cognizance the latest contributions of physiological chemistry. This applies, for example, to the various chapters on enzymes, proteins and their derivatives. Other portions can not be considered as equally up-to-date. Reiterations are abundant and there is little indication of a constructive editorial supervision. Old statements, handed down through a generation of text-books, are incorporated with the conventional reverence for outlived authority. The parts on meat products furnish illustrations of what is here meant. They fail to reflect adequately the recent progress in the study of muscle extractives. So long as an attempt is made to expand the volume to include descriptive biochemistry as well as analytical procedures, it ought to be done as well as present-day knowledge permits. Yet the "ptomaine" story is brought along in its original make-up, with well-defined muscle components like betaine classed along with the unknowns of putrefying tissues. It is unfortunate that an American editor should omit reference to the comprehensive work of J. P. Street (1908) on the

composition of commercial meat extracts. This valuable investigation is not even catalogued in the historical summary (p. 397) though less pretentious earlier and later contributions are included. The heterogeneous character of some of the descriptive text is shown by the inclusion, in the chapter on meat products, of statements like the following: "Diastatic enzymes occur in the saliva, pancreatic juice, blood, lymph and liver," etc. Why figures of wasp's muscle or fibers from the human vocal muscle or sketches of smooth muscle nuclei from the dog's artery should be incorporated in the text descriptive of serological identification of meats is not clear. The expression "xanthine bases" begins to have an antiquated look, now that the word "purine" has come into common use.

Shortcomings might be pointed out in other chapters. The vegetable enzyme papain, which is a widely sold commercial product, is dismissed with three lines taken from the British Pharmacopœia. The hæmometer of v. Fleischl is pictured and described in the text, with mere footnote reference to its improved successors. Some of the parts, like that on mucin, should either have been brought up-to-date or omitted. The standard work of Gies and his collaborators, and other comparatively recent contributions and working directions are not even mentioned (*cf.* p. 628). This is in striking contrast with the modernized chapters on proteins in other parts of the book. Elastin is described under fibroids and said in one paragraph to "contain no sulphur," whereas in another the content of sulphur is summarized in tabular form (p. 631). The word "keratoid" appears to be coined as a synonym for keratin. Typographical errors, particularly in the foreign proper names, are not missing. In some cases one is at a loss to know from the context whether the form presented is a mistake or an intentional innovation; for example, protase (p. 290); glutenins (glutelins?) (p. 34); spoilage (p. 309). The chapter on proteins of milk by L. L. Van Slyke, by way of contrast, is an illustration of how a very diffuse literature can be reviewed critically by an expert and presented in a brief yet comprehensive fashion in its theoretical and applied aspects.

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*Some Minute Animal Parasites or Unseen Foes in the Animal World.* By H. B. FANTHAM and ANNIE PORTER. London, Methuen & Co., Ltd. 1914. Pp. xi + 319. Frontispiece and 56 text-figures. 5s. net.

This interesting and valuable addition to the general literature of protozoology will be welcomed by those students of the protozoa who are chiefly interested in the practical or pathogenic side as opposed to the theoretical and speculative. It deals only with parasitic forms responsible for some diseases of man and animals and gives a full account, in simple words, of the known life history in each case and as it appears to the writers.

Of the sixteen chapters the first and last two are more general, giving, in brief outline, the chief types of protozoa, and the more general aspects of the parasitic forms. Here the authors come dangerously near the theoretical or at least controversial grounds which they appear desirous to avoid. The second chapter is devoted to *Trypanosoma gambiense* and sleeping sickness, the third to other species of trypanosomes and to the allied genera *Crithidia* and *Herpetomonas*. The fourth chapter deals with the spirochætes in a manner "which shall be as non-controversial as possible, and which will consist of facts and not the speculations so fashionable nowadays" (p. 64). The authors adhere so consistently to this promise that the reader would never know from the text that thousands of others have worked with these organisms and that there is good ground for different points of view from those presented. He would also look in vain for a description of the spirochæte of syphilis, probably the most important member of the group. In the fifth chapter there is a very good, although somewhat dramatic account of the malarial organisms of man and birds, with excellent practical suggestions regarding the breeding of mosquitoes and means

of exterminating them. The sixth chapter, dealing with coccidiosis, gives an excellent account of some common diseases of the poultry yard, but omits even a reference to coccidiosis in man. The seventh chapter is devoted to the organisms of amœbic dysentery; the eighth to yellow fever, the authors being noncommittal as to the nature of the organism producing it and confining themselves to the clinical aspects of the disease and to the mosquito which transmits it. The ninth chapter is devoted to species of the genus *Babesia* (*Piroplasma*) and the cattle diseases caused by them; the tenth to the organisms of kala azar and oriental sore. The eleventh chapter treats in a convincing manner of the microsporidian diseases of bees and silkworms, and the twelfth of myxosporidian diseases of fish. The thirteenth and fourteenth deal with parasitic ciliates, and with *Sarcocystis, Rhinosporidium* and *Neurosporidium.*

The book is written in simple style and with the untrained reader in mind. The result is a perfectly clear and intelligible account of the part played by different types of protozoan parasites and by their intermediate hosts, while the life histories are sketched with sufficient detail to permit of effective prophylaxis by amateurs. To the scientific reader, however, the style is somewhat aggravating and the arrangement of material more so. He is told in the opening chapter that the Protozoa are distributed in five great groups: *Sarcodina, Mycetozoa, Mastigophora, Sporozoa* and *Infusoria,* but from this point on there is no effort at systematic treatment. Certain flagellates are first described in detail; next come a few members of the spirochæte group which are regarded as lying "on the border line between animals and plants" (why not between flagellates and bacteria?). Then the reader jumps to the *Hæmosporidia* to learn about malaria and mosquitoes, which the authors speak of sometimes as gnats, sometimes as flies, correctly enough, to be sure, but somewhat colloquial. This is followed by an extended account of intestinal diseases of poultry due to certain species of *Coccidium* which the authors persistently call *Eimeria.* The next jump is to the parasitic amœbæ of man which are skilfully treated. The reader then skips back to the *Hæmosporidia* to learn about piroplasmosis, and then back again to the flagellates to read about leishmaniosis, while another saltation brings him once more to the Sporozoa, where he finds an excellent treatment of microsporidiosis of bees and silkworms and a less satisfactory account of myxosporidiosis of fish. To the mind of the reviewer the book would have been materially improved by more systematic treatment along the lines of either taxonomy or mode of infection, *e. g.,* by contamination, by flies and other insects, by arachnids, leeches, etc. Why should *Trypanosoma, Herpetomonas* and *Crithidia* be widely separated from *Leishmania,* to which they are closely related systematically? Or why should *Plasmodium* be widely separated by intervening coccidia and rhizopods from *Babesia?* Yellow fever also, in our ignorance of the causative agent, would have been better placed after malaria as a mosquito-borne disease.

Editorially the work is prepared with care, and comparatively few slips have passed unnoticed. Some uncertainty exists in regard to the termination in words like leishmani*asis,* microsporidi*osis,* myxosporidi*asis,* etc., but as both forms are in current use it can not be called an error. "Sex" is used in the sense of fertilization by union of two cells (p. 3). Inheritance of acquired characters is credited to some Protozoa (p. 287 and p. 297). A peculiar expression is found on p. 264: "Multiplication among Ciliates is abundant"; and another on p. 162: "It was then that the cases of yellow fever that have visited England were chiefly notified." A mis-statement is made in connection with the nuclear reorganization of ex-conjugants, on p. 265; and another in which it is implied that all free-living ciliates bear trichocysts, on p. 264; and an oversight in proof-reading was responsible for the slip: "each of the two give rise" (p. 178). These, however, are small matters which take away nothing from the value of the book. On the other hand, its value might be enhanced by better arrangement of material and by a

critical treatment of their own and of others' work, together with a more generous appreciation of the possibility that some other investigators might also be gifted with the powers of correct observation.

GARY N. CALKINS

## SPECIAL ARTICLES

### DIRECT PROOF THROUGH NON-DISJUNCTION THAT THE SEX-LINKED GENES OF DROSOPHILA ARE BORNE BY THE X-CHROMOSOME

IN "Non-disjunction of the Sex-chromosomes of *Drosophila*," *Jour. Exp. Zool.*, November, 1913, the following case was presented:

1. In certain strains involving sex-linked characters, females arose which could not be explained upon the ordinary mechanism of sex-linked inheritance. These females were maternal in appearance, showing those *sex-linked characters* which the mother showed, but no influence of those borne by the father.

2. Breeding results showed that genetically as well as somatically these exceptional females were exact duplicates of their mother in that they carried no sex-linked genes introduced by the father.

3. Such exceptionally produced females inherit directly from their mother the power of producing like exceptions; for these females, in turn, gave in $F_1$ when outcrossed to any male, five per cent. of daughters like themselves somatically and genetically. The remaining daughters are, in appearance, of the types expected on normal sex-linkage.

4. Exceptionally produced females gave in $F_1$ a class of sons (five per cent.) complementary to the matroclinous daughters in that these sons both somatically and genetically were purely paternal, having no sex-linked characters introduced by the mother.

5. The entire set of sex-linked genes of the mother, or the entire set of sex-linked genes of the father, appeared without addition or loss in the matroclinous daughters or patroclinous sons, respectively. This result was independent of the particular composition of the mother or father and held when the mother was mated to any male.

6. The exceptional $F_1$ males (patroclinous) when outcrossed to unrelated females did *not* give rise to exceptions in $F_1$.

7. By breeding in each generation from the exceptional daughters a "pseudo-parthenogenetic" line was maintained in which a given sex-linked constitution was handed down indefinitely from daughter to daughter.

8. The exceptional daughters resulted from the fertilization of an egg of the mother by a normal sperm from the father, as was proved by the introduction into the exceptional daughters of *non*-sex-linked genes from the father. The inheritance was uniparental with respect to sex-linked genes, and biparental and quite regular with respect to non-sex-linked genes.

9. The cytological work of Miss Stevens was referred to as showing that in *Drosophila* the female has two $X$-chromosomes and the male an unpaired $X$. (See, however, section 17.)

The explanation advanced for this series of facts was that *the sex-linked genes were borne by the X-chromosome, and that ten per cent. of the eggs of the exceptional females retained both X-chromosomes or, conversely, lost both to the polar body.*

It was suggested that the cause of the non-disjunction was itself a sex-linked gene.

Work which has been carried out since the previous paper was published enables me to add the following points:

10. Half of the expected class of *daughters* from a non-disjunctional female by any male, inherit directly from their mother the same power of producing five per cent. of matroclinous daughters and patroclinous sons. For example, white non-disjunctional females mated to wild males gave in $F_1$ the following:

| Expected classes. | Exceptions. |
|---|---|
| 95% of both sexes. | 5% of both sexes. |
| Wild type ♀; white ♂. | White ♀; wild type ♂. |

Half of the wild-type daughters (all were heterozygous for recessive white) when outcrossed to barred males (barred is a dominant sex-linked character) gave exceptions as follows:

| Expected classes. | Exceptions. |
|---|---|
| 95% of both sexes. | 5% of both sexes. |
| Barred ♀ (2); wild type ♂ (1); white ♂ (1). | Wild type ♀; barred ♂. |

11. Non-disjunctional females are diploid in constitution, for (see 10) they can be *heterozygous* in various sex-linked genes, and they then give all the expected classes in the normal proportions.

12. Half of the *expected* class of *sons* (from any non-disjunctional female by any male) *transmit* the power of producing exceptions, although they themselves do not possess that power. Thus, half the white sons of a white non-disjunctional female outcrossed to wild females give in $F_1$ only the expected classes of wild-type females and wild-type males. If these wild-type daughters are tested by outcrossing to barred males exceptions are found among their offspring.

13. Those sons (half the expected class) which do transmit the power of producing exceptions transmit it *to only some of their daughters and not to all.* Thus of the wild-type daughters tested (in 12) by barred males only approximately half showed exceptions, the others giving only expected classes.

14. The *patroclinous sons* of a non-disjunctional female do not transmit non-disjunction to any of their offspring.

15. Attempts to localize a gene for non-disjunction in the series of sex-linked genes showed that no such definite locus in the series could be assigned to non-disjunction as has been assigned in the case of all sex-linked genes. Non-disjunction was found to assort freely from all sex-linked genes tried.

16. Attempts to obtain pure stock of non-disjunction failed. Had there been an $X$-chromosome gene involved, the rigorous method used would not have failed to yield a stock pure for that gene.

17. Recent cytological investigation has clearly shown that normally in *Drosophila ampelophila* the female bears two $X$-chromosomes, and the male an unequal $X$–$Y$ pair (see 9).

This last fact requires us to substitute the term $Y$-bearing sperm for "no-$X$" sperm and $Y$-egg for no-$X$ egg in our explanation.

The breeding work (especially 13, 15 and 16) showed that an $X$-chromosome gene could not be the cause of the phenomenon, and the cytological work (see 17) supplies us with an adequate cause in the *supposed* presence in the exceptional females of a $Y$-chromosome in addition to the normal two $X$-chromosomes.

The prediction was accordingly made that half the daughters of a non-disjunctional female would be found to contain in addition to the two $X$-chromosomes a supernumerary chromosome which is a $Y$.

18. *Cytological investigation has shown that approximately one half of the daughters of a non-disjunctional female do in fact contain a supernumerary Y-chromosome, while the remaining half contain only the normal two X-chromosomes.*

The sex-chromosomal constitution of a non-disjunctional female is $XXY$. In 90 per cent. of the maturations the sex-chromosomes must be placed in opposition to each other in such a way that an $X$ and $Y$ both pass to one pole, and a single $X$ to the other. In ten per cent. of the maturations, however, the chromosomes must oppose each other in such a way that the $Y$ passes to one pole by itself and the two $X$-chromosomes pass to the other pole together.

The fertilization of these types of eggs by the spermatozoa of an unrelated male of the constitution $XY$ explains the genetical results as follows:

The $XX$ eggs (5 per cent.) by the $Y$-sperm give *females* ($XX$ = female) having each a supernumerary $Y$-chromosome. These females will be exact duplicates of their mother with respect to their chromosomes, *and the breeding work showed that they are exact duplicates with respect to all sex-linked genes* (see 1, 2 and 5). *This parallelism can only be explained by assuming that the X-chromosomes do in reality bear the genes for the sex-linked characters.*

Furthermore, since these females received no $X$-chromosome from the father they can neither show nor transmit sex-linked characters from the male (see 1 and 2).

Since the composition of these females is $XXY$, they will themselves have the power of producing exceptions as did their mother (see

3). The particular composition of the mother can thus be handed on indefinitely from daughter to daughter (see 7).

Only the sex-chromosomes are concerned in this unique maturation and breeding results show that only sex-linked characters are subject to exception in these cases (see 8).

The $Y$-eggs (5 per cent.) by the $X$-sperm give males ($XY$) with no supernumerary chromosomes. These males have received their $X$-chromosomes from their father and the breeding results (see 4) show that in all sex-linked characters (see 5) they are exact duplicates of the father.

These males will be able neither to produce exceptions (see 6) nor to transmit the power of producing exceptions (see 14) since their chromosome mechanism is that of any ordinary male (see 17).

The $XY$-eggs (45 per cent.) by the $X$-sperm will give females (diploid with respect to $X$ (see 11)) which will, to all appearances, be the type expected from the cross, since they will exhibit characters from either or both parents. But since they contain a supernumerary $Y$-chromosome they will themselves be able to produce exceptions, and breeding tests showed that half the expected females do in fact produce such exceptions (see 10).

19. Such non-disjunctional females which are heterozygous for recessive characters, when bred to any male, produce exceptional daughters which are of one type only, namely, heterozygous dominants. This fact shows that the *non-disjunction occurs at the reduction division,* for if at the reduction division the $X$-chromosomes separated the egg would receive either the dominant bearing chromosome or the recessive bearing chromosome. After the following equational division of the chromosomes two *like* chromosomes would be produced, both dominant or both recessive bearing. If non-disjunction occurred at this stage (2d polar body) exceptional daughters pure dominant or pure recessive would appear. Since females of this type do not appear, we must conclude that the non-disjunction occurs normally at the reduction division and not at the equation division.

The $XY$-eggs (45 per cent.) by $Y$-sperm give males ($XY$ = male) with a supernumerary $Y$-chromosome. Since these males receive their $Y$-chromosomes from their mother they will be of the expected classes of sons (see 12). In the spermatogenesis of such males the extra $Y$ may go either with $X$ or with the other $Y$ and these two cases seem to occur with equal frequency. The spermatozoa of such a male are then of four types: $XY$—$Y$—$X$—$YY$. When mated to any female only expected offspring could appear (see 12). The types $XY$ and $X$ are female producing. Some of the daughters produced will thus have a supernumerary $Y$ and will themselves produce exceptions (see 12 and 13).

Some of the sons of such a cross would possess the power of transmitting non-disjunction as did their father of like composition (see 12 and 13). Although the presence of the males having the composition $XYY$ has been proven genetically, their occurrence has not yet been studied cytologically.

If in a non-disjunctional female $Y$ went equally often with either $X$, then no linkage would be shown between non-disjunction and any sex-linked gene (see 15).

Likewise the method which would unfailingly secure a pure stock of any sex-linked gene is utterly useless for a freely segregating $Y$-chromosome (see 16).

In conclusion, *there can be no doubt that the complete parallelism between the unique behavior of the chromosomes and the behavior of sex-linked genes and sex in this case means that the sex-linked genes are located in and borne by the X-chromosomes.*

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## HOT WATER TREATMENT FOR COTTON ANTHRACNOSE

DURING the past three months we have been making a study of the effect of hot water at different temperatures on the anthracnose fungus and cotton seed. The results are very interesting and seem to have an important bearing on the control of the disease. Cotton anthracnose is known to be carried in the seed. The fungus penetrates the seed coats

and the hyphæ and spores have been found in the cotyledons on the inside of the seed while the seeds were still in a dormant condition. So far, no treatment has been reported which will kill the fungus without killing the seed. Our hot water treatment studies were made with a view of determining whether or not the fungus could be killed by hot water without injuring the seed. Our results so far are very encouraging and are considered to be of sufficient importance to warrant publication at this time of this preliminary statement.

To begin with, we placed cotton seed in water at different temperatures and for different lengths of time and then germinated them between blotters in the ordinary way in incubators with a view of determining how high a temperature cotton seed would stand without injury. As a result of these tests we find that cotton seed can remain in water at 70° Centigrade for fifteen minutes without injuring the germination. 50 per cent. of the seed germinated that were allowed to stand in water at 75° Centigrade for fifteen minutes. In a few cases more than 50 per cent. of the seed germinated that had been treated five minutes at 80° Centigrade, but in the majority of cases a very small per cent. of the seed treated for five minutes or longer at 80° germinated.

The fact that cotton seed which had been allowed to stand in water at 70° Centigrade for fifteen minutes germinated as well as the untreated checks prompted us to germinate a large number of treated seed under sterile conditions and to examine the seedlings for anthracnose. We used for this purpose the method which has been in use in this laboratory for the past four years for testing seed for disease by germinating them in sterile test tubes.[1] These tests seem to show conclusively that the fungous hyphæ and spores in the seed are killed when cotton seed is allowed to remain in water at 70° Centigrade for fifteen minutes and the germinating power of the seed is not injured. An average of 22 per cent. of the seedlings in the checks from the same lot of seed and germinated under the same conditions were diseased. We now have two fields on the college farm planted with seed which were given this treatment and so far there is no indication of disease in the seedlings, while in the fields planted with the same lot of seed but not treated diseased seedlings are abundant. The field tests will, of course, not be complete until the end of the season when the plants are all mature.

[1] Twenty-fourth annual report of the South Carolina Experiment Station, page 43.

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W. B. Aull

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## *THE AMERICAN CHEMICAL SOCIETY. IV*

### WATER, SEWAGE AND SANITATION SECTION

Edward Barton, Chairman

H. P. Corson, Secretary

*A Sanitary Survey of White River:* John C. Diggs.

During the summer of 1913 a sanitary survey was conducted on the West Fork of White River, an Indiana stream 388 miles in length. A knowledge of the condition of this river is of great importance because this stream is used as a public water supply and means of sewage disposal for cities whose population totals over 300,000. A great part of the work was conducted from a floating laboratory, which served also as the living quarters of the members of the surveying party. Private and public water supplies of cities bordering the river were also examined and sanitary surveys conducted in towns visited.

*Hypothetical Combinations in Reporting Water Analyses:* Richard B. Dole.

Various common methods of making hypothetical combinations were illustrated in order to show the wide divergence of practise in America, and the combinations were interpreted in order to show the similarities and differences of opinion as to the quality of a given water. The author emphasized the advisability of distinguishing between the facts of analysis and the opinions expressed as hypothetical combinations. He also showed how the value of water may be deduced from the ionic statement without reference to hypothetical combinations and quoted the opinions expressed by several authors and scientific associations as to the advisability of reporting water analyses in ionic form and omitting the report in hypothetical combinations in order that analyses by different chem-

ists may be compared and the error of analysis may not be concealed. As the order of making hypothetical combinations is purely conventional the author strongly urged that no scheme of making such combinations be included in the report of the Committee on Standard Methods of Water Analysis but that the data of the analysis be reported in ionic form.

*New Apparatus for the Determination of Hydrogen Sulfide in Water:* GEORGE B. FRANKFORTER.

*Sanitary Survey of the Ohio River by the U. S. Public Health Service:* W. H. FROST AND H. W. STREETER.

*The Use of Liquid Chlorine in Treating the Water Supply of Indiana Harbor, Ind.:* H. E. JORDAN.

*The Adaptation to Water Analysis of the Determination of Potassium as the Perchlorate:* CLARENCE SCHOLL.

A detail comparison of the platinic chloride and perchlorate methods of determining potassium is given. The cost of the latter is about 0.7 per cent. of the former. The ease in manipulation is also much greater in the perchlorate method. The results obtained are accurate. The perchlorate method is then given in detail. The sulphate and ammonium ions and all volatile acids must be removed. The residue is evaporated to dryness with perchlorate acid until all the salts are perchlorates. The perchlorate salts of all the common elements except potassium are soluble in 96 per cent. to 97 per cent. alcohol containing 0.2 per cent. $HClO_4$. The potassium perchlorate obtained is weighed in Gooch crucibles after drying one hour at 120°–130°. The method was used on many waters containing known amounts of potassium. The errors are small. The phosphate radicle has no effect on the determination. The perchloric acid is now available to every chemist. The method can be recommended for use in water analysis and probably for all other analytical work where the content of potassium is desired.

*The Preparation of Standards for the Determination of Turbidity of Water:* FRANCIS D. WEST.

*Report of the Committee on Standard Methods of Water and Sewage Analysis.*

*Chemical Studies of the Pollution of the Ohio River:* EARLE B. PHELPS.

The investigation of the Ohio River now being conducted by the U. S. Public Health Service under the direction of Passed Assistant Surgeon Wade H. Frost has for its object the determination of the extent and character of present pollution, the capacity of the stream to care for this and future pollution, and the effect, if any, upon the public health of riparian communities. It is hoped in addition to obtain data for a general discussion of the principles of self-purification of streams. The capacity of a stream for re-aeration determines its capacity to dispose of pollution. The general laws of re-aeration are known but their application to a stream requires the determination of certain constants, characteristic of each stream type.

*Investigation Relating to the Use of Calcium Hypochlorite as a Disinfectant for Water Supplies:* W. G. TICE AND C. H. BLANCHARD.

*Some Further Results of the Hypochlorite Disinfection of the Baltimore City Water Supplies; A Comparison of the Reduction of the Different Members of the B. coli Group:* J. BOSLEY THOMAS AND EDGAR A. SANDMAN.

The hypochlorite treatment of the Baltimore city water supplies was instituted in June, 1911, pending the erection of a filtration plant. In one supply the hypochlorite was added at the impounding reservoir; in the other supply, constituting about three fourths of the consumption, it was found feasible to apply the disinfectant at the effluent of the first storage reservoir, after the water had received a preliminary treatment with aluminum sulfate. The treatment effected a reduction of 99 per cent. of the organisms growing at 20° C. in the sedimented water of one supply, and 83 per cent. in the other supply, where no coagulant was added previous to the disinfectant. The reductions in the numbers of organisms growing at 37° C. were 85 per cent. and 76 per cent. respectively. There was but little difference in the relative reductions of the members of the *B. coli* group, these reductions being between 97 and 99 per cent., based upon about fifteen hundred isolations. The number of cases of typhoid fever occurring in Baltimore during 1913 was seventeen per cent. less than an average of the number of cases occurring during the five years from 1906 to 1910 before the treatment was instituted.

*Filtration and Softening of the Cleveland Water Supply:* HIPPOLYTE GRUENER.

The Cleveland water situation is marked by a comparatively high grade of raw water, both as respects its hardness and bacterial content. The increase of the typhoid rate resulted in 1911 in the use of bleaching powder. Popular objections to this combined with the conditions after the flood of 1913 led to the decision to filter. The rapid

sand method was adopted and a test filter put into operation at once. Lime and iron were used, particularly with reference to softening. The dosage was determined in the end empirically. The results have been absolutely satisfactory. Turbidity, zero. Bacterial count, low, with absence of gas formers. Hardness, reduced from 116 p. p. m. to 55. Laundry and boiler tests have also been made with satisfactory results. Further plans for the filter plant, as also for sewage treatment are nearly completed.

*The Relation between Aluminum Sulphate and Color in Mechanical Filtration:* Frank E. Hale.

Filter alum and alkalinity combine at ordinary temperature to form monobasic carbonate of aluminum, at 100° F. probably dibasic.

Color in water is acid and combines with the hydroxide radicle of the alum precipitate. The direct aluminum compound is soluble (boiling reaction). Neutral color combines directly with alum to form probably $AlR_2(OH)$ and residual acid color. This has resulted in removing double amounts of color per same amount of alum, neutralizing excess alum by raw water. High alkaline waters form soluble aluminates and require more alum. Acidity of color shown by removal of expected acidity proportional to removal of color, by residual acidity not removed by aeration or boiling, by neutralization of acidity preventing alum reaction, by removal of color of different waters proportional to color acidity, by deepening of color by alkali, by prevention of alum reaction by combined iron, by removal of color by magnesium hydrate, and lastly definite chemical action is indicated by definite color removal by definite amounts of alum.

### Division of Organic Chemistry

F. B. Allan, Chairman

C. G. Derick, Vice-chairman and Secretary

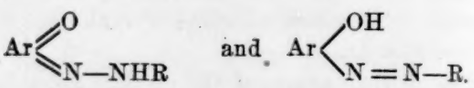
The division of organic chemistry held its meetings Wednesday morning and all day Thursday, the 8th and 9th of April, respectively, with Chairman F. B. Allan presiding. Of the twenty-four papers listed in the program, nineteen were presented. The symposium on "The Teaching of Organic Chemistry" was held according to the program. These meetings were marked by a very thorough discussion of each paper, with a very few exceptions, and all organic chemists present agreed that the division meetings were the most interesting that they had attended. The average attendance at each meeting was fifty. Dr. R. R. Renshaw was appointed by the division as a committee to draft a questionnaire concerning the teaching of organic chemistry which should be submitted to the division at the Montreal meeting in September.

*The Chemistry of Enzymic Action:* J. U. Nef. (One hour.)

*The Constitution of Acetylacetone-thiourea:* W. J. Hale.

*A Contribution to the Study of the Constitution of Hydroxyazo Compounds:* Wm. McPherson and George W. Stratton.

The authors discussed the methods used in attempting to isolate isomeric compounds of the general formulas




*The Preparation and Properties of Some New Orthobenzoquinones:* Cecil Boord and Wm. McPherson.

$\beta$ ethyl-, $\beta$ *n*-propyl-, $\beta$ *t*-butyl- and $\beta$ *t*-amylorthobenzoquinones have been prepared. The method of Jackson and Koch, using anhydrous ether as a solvent, and also that of Willstätter and Pharmensteil have been used in each case.

The two crystalline forms observed by Willstätter in the case of orthobenzoquinone itself, have been observed in each case. Also with an increase in the size of side chain the stability of each of the crystalline forms is increased.

*The Oxidation of Propylene Glycol:* Wm. Lloyd Evans, E. J. Titzemann and P. R. Cottringer.

*A Study of the Mechanism of the Grignard Reaction:* Lambert Thorp and Oliver Kamm.

Evidence is furnished leading to the conclusion that the Baeyer-Villiger oxonium structure for the Grignard compounds is to be preferred to the structure assigned by Grignard and Stanikoff. The authors do not, however, believe that an oxonium structure need be assumed in order to account for the behavior of the Grignard compounds.

*The Structure of the Three Dihydro-β-naphthoic Acids:* C. G. Derick and O. Kamm.

Two dihydro-$\beta$-naphthoic acids having an unsaturated linking in the ring carrying the carboxyl have previously been prepared and the structure of one of them demonstrated. In the present work the preparation of the third isomeric acid is described and a demonstration of the struc-

ture of all three isomers, based upon the reactions of their respective dibromides, is offered.

*The Rearrangement of Trioxylmethyl Azids:* JAMES K. SENIOR.

The rearrangement of triphenylmethyl azid $(C_6H_5)_3$—C—$N_3$ by the action of heat into phenylimidobeerzopherone was made extremely likely by the discovery of this rearrangement in the case of triphenylmethyl hydroxylamine under the influence of dehydrating agents, and of triphenylmethyl halogen amines under the influence of alkalies. Experiment proved the correctness of the anticipation.

*The Action of Trioxymethylene on the Various Hydrocarbons in the Presence of Aluminium Chloride:* GEO. B. FRANKFORTER AND V. R. KOKATNUR.

This work was begun with the idea of extending the use of anhydrous aluminium chloride as a dehydrating reagent, at the same time throwing light, if possible, on the constitution of trioxymethylene. So far, little knowledge has been added to the molecular structure of the latter. However, the use of aluminium chloride as a dehydrating agent has been extended. It has been shown, by treating benzene and trioxymethylene with aluminium chloride, that diphenylmethane and anthracene were obtained; with toluene, ditoluylmethane and dimethylanthracene; with xylene, dixylylmethane and tetramethylanthracene, and finally with mesitylene, dimesitylmethane, tetramethylanthracene and durene.

*Studies on Organic Periodides. I. Periodides of Methacetin, Phenacetin and Triphenin:* W. O. EMERY.

*Periodides of Antipyrin:* W. O. EMERY AND S. PALKIN.

*Molecular Rearrangements of Hydrazines:* JULIUS STIEGLITZ AND JAMES K. SENIOR.

Rearrangements of hydrazines corresponding to the rearrangement of oximes (Beckmann) and of hydroxanic acids are not described in the literature. Attempts are made by the authors on a number of hydrazones and hydrazines on account of the fundamental analogy between hydroxylamine derivatives and those of hydrazine, but until recently the attempts were unsuccessful. A source of the failure was thought to lie in the existence of two possible *electronic* structures for hydrazines and hydrazones. To avoid this possible difficulty the rearrangement of symmetric di-triphenylmethylhydrazine

$$(C_6H_5)_3C\cdot M_2^{+-}\cdot M_2C(C_6H_7)_3$$

was tried and was found to proceed successfully under the influence of zinc chloride. The results promise to throw light on these rearrangements and on the electronic structures of the compounds involved.

*The Phosphates of Destearin:* R. R. RENSHAW AND R. R. STEVENS.

*Electromers and Stereomers with Positive and Negative Hydroxyl:* L. W. JONES AND L. F. WERNER.

*Halogen Substituted Hydroxamic Acids:* L. W. JONES AND L. F. WERNER.

*Formyl-β-benzylhydroxylamine:* L. W. JONES AND M. C. SNEED.

*The Addition Compounds of Dimethylpyrone with Organic Acids:* JAMES KENDALL.

The addition compounds of monobasic aliphatic and aromatic acids, and also of phenols, with dimethylpyrone have been investigated by the freezing-point method. Thirty-two substances were examined, and the existence of thirty-seven compounds, most of which have not previously been described, has been demonstrated. The compounds obtained were of three general types: $C_7H_8O_2$, Hx; $2C_7H_8O_2$, 3Hx; and $C_7H_8O_2$, 2Hx. A consideration of the results leads to the view that the reaction is ionic, and that the compounds formed are true oxonium salts. The method is of general application for the study of organic addition reactions.

*Errors in the Dumas Method for determining Nitrogen Due to Occluded Gases in Copper Oxide:* C. A. TAYLOR AND A. C. FIELDNER.

*The Isomeric Octacetates of Lactose:* C. S. HUDSON AND JAMES M. JOHNSON.

The octacetate of lactose already known was purified until a m. p. of 90° (uncorr.) and a specific rotation in chloroform of $(L)_D^{20} = -4.3°$ were obtained. By means of zinc chloride in acetic acid at room temperature, this compound was rearranged into a new isomeric octacetate which was obtained crystalline with a m. p. of 152° C. (uncorr.) and a specific rotation in chloroform of $(L)_D^{20} = +53.1°$. Lactose was regenerated from both isomers.

*Substitution in the Benzene Nucleus and in the Side Chain from the Standpoint of the Electronic Conception of Positive and Negative Valences:* H. S. FRY.

*The Salts of the Acridines:* L. H. Cone.

Free radicals analogous to triphenylmethyl have been isolated from the salts of diphenylacridol and N-methylphenylacridol. These free radicals behave in every way analogous to triphenylmethyl, yielding peroxides on exposure to air and adding on halogens, etc. From these facts the conclusion is drawn that in all probability the salts of the acridines are quinocarborium salts analogous to the quinonoid form of triphenylchloromethane from which triphenylmethyl comes, at least in part. This conclusion is at variance with the accepted ammonium formulation of the salts of the acridines.

*The Action of Halogen on 4-Nitro-m-Cresol:* L. Chas. Raiford.

The experiments of Kehrmann and Tichvinsky on the chlorination of 4-nitro-m-cresol have been repeated, and the experiments varied so as to use pure chlorine as well as mixtures with carbon dioxide. Instead of 6-chlor-4-nitro-m-cresol only, as reported by K. and T., 75 per cent. of the product was found to 2-chlor-4-nitro-m-cresol, and but 5–10 per cent. of the compound with chlorine para to methyl. Chlorination with mixtures furnishing so-called nascent chlorine, gave nothing but 2-6-dichlor-4-nitro-m-cresol.

*A Simple Method for the Determination of the Accuracy of the Conductance Data of Organic Electrolytes:* C. G. Derick.

The use of the linear plotting functions to test the precision and presence of constant errors in conductance data has been found unsatisfactory in the hands of beginning research men. In the case of the weak and transition electrolytes, the calculation of the molar conductance at zero concentration has been found to be a very satisfactory criterion for both precision and constant errors of the conductance data of organic electrolytes. Its sensitiveness may be varied and no mechanical skill is necessary in its application. Its application to existing measurements on the conductance data of weak electrolytes shows that these data are very inaccurate as a rule.

*The Ionization Constant of Pyroracemic Acids:* C. G. Derick and St. Elmo Brady.

The unsatisfactoriness of the use of the ordinary criteria of purity of organic compounds is emphasized. Organic chemists are urged to use additional criteria such as the ionization constants. This statement was emphasized by the measurements of the conductance data on pyroracemic acid. Also the application of its calculated molar conductance at zero concentration as a criterion of the precision and constant errors in the measurements was illustrated.

*On Cyanoacetic Ester:* John C. Hessler.

The alkylation of cyanoacetic ester by means of sodium ethylate and alkyl haloids gives large amounts of di-alkyl cyanoacetic ester. Methyl iodide gives 12.3 per cent., ethyl iodide 30 per cent., ethyl bromide 28 per cent., normal propyl iodide 35 per cent., isoamyl iodide 28 per cent., of the di-alkyl cyanoacetic ester. The heating of these di-alkyl esters with concentrated hydrochloric acid in sealed tubes is an unsatisfactory method of saponification. Caustic potash in pure methyl alcohol reacts ideally in the cold, giving the di-alkyl cyanoacetic acids in theoretical quantity. The salts of these acids, and their acid chlorides, amides, anilides, etc., have been prepared.

The Conrad-Limpoch reaction has also been carried out in methyl alcoholic solution. The yields are small, yet the alcohol is as anhydrous as it seems possible to make it. The products are *methyl* esters, not ethyl esters, owing to an exchange with the methyl group of the alcohol. When benzyl chloride is used in place of the alkyl haloids a large amount of di-benzyl cyanoacetic methyl ester is obtained. This is a beautifully crystalline solid melting at 78°–79° C.

The investigation is being continued with the use of propyl, isobutyl and isoamyl alcohols as solvents.

On Thursday a symposium on the teaching of elementary organic chemistry was held with the following papers:

I. *Theory of Elementary Organic Chemistry:* J. B. Allan, Chairman.

"The Teaching of Elementary Organic Chemistry without the Use of Atomic and Molecular Hypotheses."

II. *Theory of Organic Chemistry for Graduate Students:* R. R. Renshaw.

"What shall be the Character of the Advanced Instruction in Organic Chemistry?"

III. *Laboratory Teaching of Organic Chemistry:* L. W. Jones.

"The Teaching of Organic Chemistry in the Laboratory."

Charles L. Parsons,
*Secretary*